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Nursery & Market Garden Industries'
- - Development Society, Limited. - -

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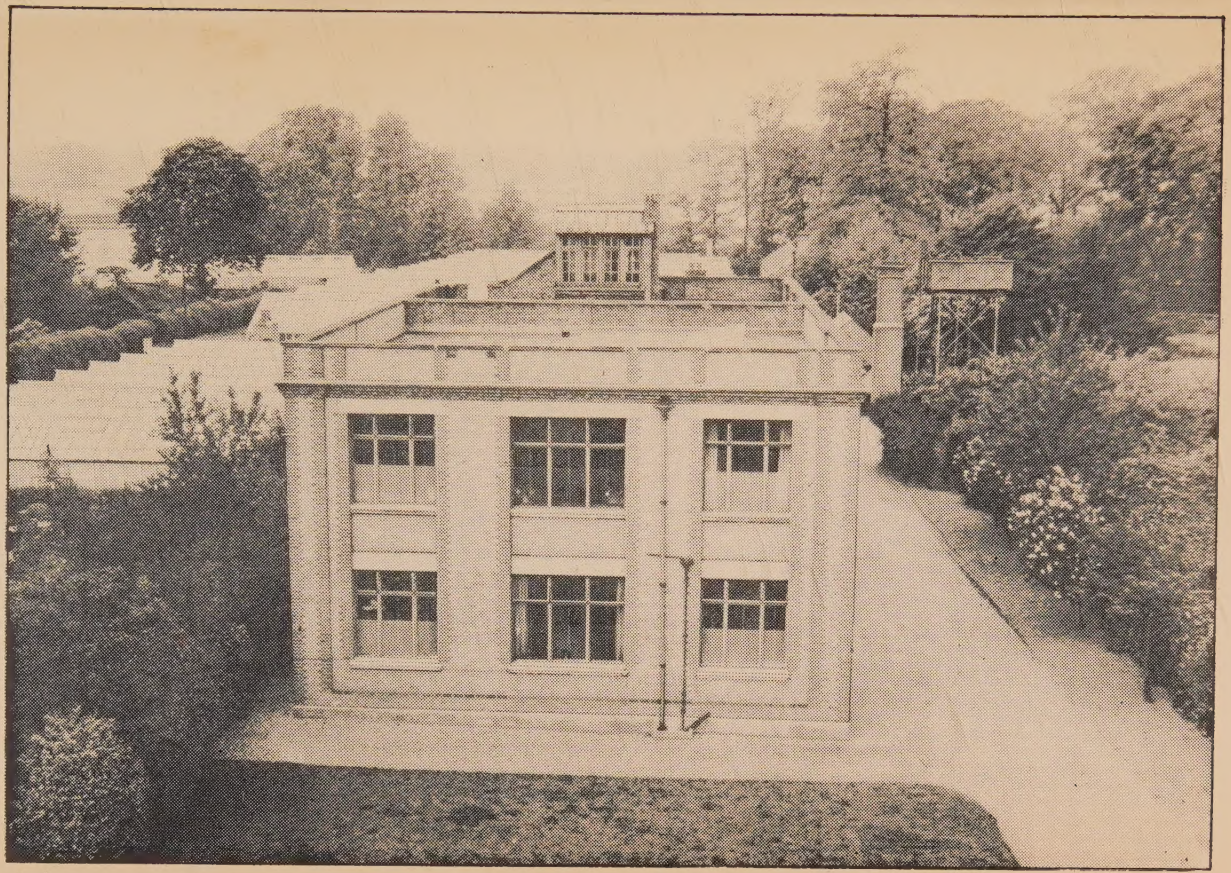

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Introduction.

THE year 1936 is noteworthy for the launching of an active campaign to improve the quality of tomatoes.

Mr. J. Harnett and the Director were deputed by the National Mark Fruit Trades' Committee to investigate the condition of tomatoes after arrival at the wholesale markets in different parts of England, and as a result of their visits during 1935 and 1936, meetings of growers have been addressed in most of the important centres.

The work of the Station for many years has been specially directed towards the investigation of the causes of poor quality fruit, and it has been possible to advise growers in their attempts to raise the standard of their produce. The results of these investigations have been described briefly in Miscellaneous Publication No. 1: "The Production of High Quality Tomatoes."

Growers all over the country have co-operated with the Station to a praiseworthy extent, and if the efforts are continued by all the general level of tomato production will be quickly raised.

Members' Day.

The "Coming of Age" celebrations organised for 1935 were so successful that many members expressed a desire for some similar meeting each year, and the first "Members' Day" was held on Thursday, June 4th. Some 200 members were conducted through the experimental houses and laboratories, in small parties, during the afternoon, and after tea in the Relph Hall, Elm Arches, the Director gave an address on "Experimental results as they affect commercial production." Fortunately the day was fine until after tea, and an enjoyable time was spent by all.

Membership.

Membership of the Society, under whose auspices the experiments are conducted, is open to all growers and interested persons. Subscriptions are payable at the rate of two guineas for each acre of glass cultivated by the subscriber; in return members receive publications and any advice which is available. Members continue to be enrolled, but many are needed, both to provide additional funds for research and to obtain complete co-operation in controlling the various pests and diseases common to glass-house plants. Serious outbreaks over a wide area must be fought by all growers; isolated attempts to control disease are almost bound to fail.

Endowment Fund.

An endowment fund has been opened to receive contributions from those who desire to further the work of the Station. The capital is invested in Trustees and the interest only will be used for *(a)* future development, and *(b)* repayment of debt.

It is hoped that those who can possibly contribute to this fund will do so, and so help to secure the Station's future financial prosperity.

Mushroom Shed.

The erection of a mushroom shed was completed at the beginning of the year. The Ministry of Agriculture provided a grant equal to half the cost of the shed, while Mr. J. Harnett supplied the heating apparatus, and Mr. Ben Rubenstein the cedar wood of which the shelves and supports were constructed.

Our grateful thanks are tendered to these gentlemen who have assisted us so generously.

Current Investigations.

The investigations with tomatoes have been directed towards obtaining more information concerning high quality fruit production, and to this end the manurial and crop management trials have been repeated.

The effect upon the quality of the fruit of restricting the root system was examined by comparing the crop from plants growing in the ground under normal conditions with that from plants growing in clay pots 10 inches in diameter, cardboard boxes, and wooden butter boxes.

The containers were placed in the glasshouse on the natural soil, into which the plants rooted ultimately. The crop yield per acre from the different treatments did not vary to any appreciable extent but there was a definite variation in quality. The fruit from plants in pots ripened earlier than the rest, and was firmer and of better colour. Next in order came the fruit from the cardboard boxes, but there was little difference in quality between the fruit from plants grown in the large wooden boxes and in the ground. The experiment indicated a beneficial effect through restricting the root system during the early part of the season. It will be repeated in 1937.

In another experiment, which occupied one-and-a-half houses, the effect of the distance between plants upon fruit quality was tested.

Normally, the plants are set out in double rows 18 inches apart, the plants being 14 inches apart in the rows. The double rows are separated by a path 27 inches wide. In one series the distance between plants was increased to 18 inches. In two others, the plants were set out in single rows 18 inches apart, while in one of these the plants were 14 inches apart and in the other 18 inches apart in the row.

The crop yield per acre from each of the four series was approximately the same, thus indicating that within the limits of the experiment the plants with greater space produced a greater yield per plant. Every attempt was made to ascertain if the quality of the fruit was affected by the closeness of planting, but the observations proved difficult owing to considerable variations in the different plots, and it seems unwise to make any definite statement at the present stage of investigations. The experiments will be repeated.

The soil warming experiments have been continued in the two houses equipped for this purpose. In the past, some difficulty has been experienced on commercial nurseries where soil warming is being tested, by reason of a too soft and rapid growth during the early stages of the crop. A means of correcting this was sought in the experiments this year. In one house the young plants were planted out in soil at a temperature of 58°F., and after the two bottom trusses had set, the soil temperature was raised at the rate of 5°F. per day until it became 80°F. At this stage thermostatic control came into operation and this temperature was maintained for a period of twelve weeks. In the adjoining house the plants were kept in the 3 inch pots until the first truss was beginning to set and were then planted in the soil at a temperature of 80°F. The first method produced a yield of 59 tons per acre and the second 52 tons per acre. The experiment will be repeated.

The soil in both of the above houses was badly infected with the tomato root eelworm, *Heterodera marioni*, during 1935, and during the winter was treated with a sterilizer of the carbolic type. The high yield obtained and the healthy appearance of the plants suggested a freedom from eelworm attack, but when the roots were removed at the end of the season they were found to be heavily infected. It is probable that infection occurred late in the year.

In comparison with the two soil-warmed houses, an adjacent house was sterilized with steam and another left untreated as a control. The yield from the sterilized soil amounted to 60 tons per acre and that from the control 48 tons per acre.

It is interesting to note that the roots from the steamed soil were quite free from eelworm infection, thus confirming the efficiency of this process as means of destroying this pest. Another point of interest is the fact that the soil warming resulted in a yield only slightly below that from the steamed house. This confirms previous experiments which indicated that soil warming is

capable of maintaining a high yield year after year, and preventing the need for sterilization except where the soil is highly contaminated with eelworms or the fungus *Phytophthora.*

In the variety trials three Potentate types occupied the first three places in order of crop weight, namely, the F_2 generation of Blaby × Potentate, Blaby × Kondine Red, and "J.H. No. 1." These types all produced large heavy fruit, which under the conditions of the experiment were somewhat irregular in shape. Further selection of the crosses should yield strains which produce fruit of better shape.

Considerable advances have been made in the leaf mould resistant types. The yields were not high but the type of growth suggests that this can be improved by systematic "stopping" of the plants. Especially promising are the crosses: E.S.1 × Up-to-date × Potentate and E.S.1 × Up-to-date × Radio. They retained their resistance to *Cladosporium fulvum*, and the five lowest trusses of fruit were extremely good.

The process of applying a layer of peat to the surface of the soil as a rooting medium was tested in a steamed house and in unsteamed houses. A rapid production of roots from the stems occurred wherever there was a tendency for the original roots to decay, but in the case of the steamed soil it was both slow and feeble because the original root system remained healthy. These results emphasise the value of this treatment wherever root action has been weakened.

In the cucumber experiments, the effect of exposing the plants to electric light in the propagating houses was examined further. Four treatments were used, two being applied from 3 a.m. to 7 a.m. and the others from 4 p.m. to 8 p.m. Two different light intensities were used morning and evening, namely, 280 foot candles and 70 foot candles respectively. The results resemble those of 1935, when although there was an increase in early crop, the total crop remained unaffected by the treatment. Irradiation may ultimately prove mainly of value with

exceptionally early crops planted in November and December in those districts where sufficiently good plants can be grown with the aid of electric light, to enable picking to commence at the end of January.

The breeding work was continued in an attempt to shorten the "neck" of cucumber fruits. Some advances have been made although satisfactory types are not yet available.

Cheshunt Early Giant lettuce was grown as a commercial crop for marketing at Christmas and also at the end of February. The variety fulfilled its early promise, both the quality and selling price of the crop being satisfactory. Seeds have now been distributed all over the country, and the opinions of growers concerning its excellence as a glasshouse lettuce for autumn and winter work are most gratifying. It is clear that this variety has satisfied a long-felt need.

Lettuce and carrots were grown in frames. Cheshunt Early Ball lettuce, which was selected at the same time as Cheshunt Early Giant, has proved to be a valuable variety for frame work. It has gained First Prize in the cold frame section at the Early Market Produce Show, Vincent Square, during the past two years. The best heads came from the frames where the soil was warmed to a temperature of 60°F. during the growth of the lettuce. There was also a noticeable absence of *Botrytis* rot.

Through the kindness of Messrs. Stewarts & Lloyds, Ltd., who generously supplied the pipes, it has been possible to install a soil warming apparatus for frame work, which is so badly needed. The experiments will begin early in 1937.

Our thanks are also due to Ideal Boilers and Radiators, Ltd., who have supplied two Gravity feed coke boilers for trial. These boilers are now heating a block of tomato houses and also the soil in the experiments with frames. They have given every satisfaction since they were installed last March.

It is also a pleasure to record our friendly co-operation with both the London and Counties Coke Association and the Coal Utilisation Council, the Officers of which organisations have assisted us continually in various fuel problems.

In the entomological investigations attempts have been made to destroy the adults and larvæ of *Thrips tabaci* concealed amongst the petals of infested carnations. Some success has resulted from the volatilisation of naphthalene in suitable lamps.

A large number of experiments have been conducted on commercial nurseries in an attempt to control thrips on roses, a pest which is becoming more serious each year and is causing considerable loss to growers. Promising results have been obtained by the use of a nicotine in oil insecticide in conjunction with cyanide fumigation.

Further work has been undertaken in an attempt to obtain a more efficient control of millepedes in cucumber beds. Numerous soil insecticides have been tested, and the best results were obtained by saturating the beds periodically with nicotine solution.

Pests of mushrooms have been studied intensively in the new mushroom shed. Injury by Phorid and Sciarid fly larvæ was recorded, and from observations upon the distribution of eggs and larvæ in the casing soil and the compost, it is believed that infection of the manure took place between the time of the last turning and the making up of the beds. Definite injury to the crop from the mite *Tyroglyphus longior* has been recorded from nurseries.

A synthetic wax emulsion for controlling the red spider mite on carnations was tested, and although it has given moderately good results it is not satisfactory because it can be applied neither to the plants when in flower nor during hot weather. In addition, it was found to injure the soft young shoots.

A large number of insecticides and fungicides have been submitted for examination and have been tested on various glasshouse pests. These have included several copper-oil emulsions for use as sprays, and also a number of mixtures for preventing outbreaks of "damping off."

In the mycological investigations further attention has been given to rust of roses, especially with regard to the germination of teleutospores. Successful germination was obtained in the case of material which had been stored outside during the winter. Attempts to infect rose trees with teleutospores failed again, although the fact that such infection actually occurs has been demonstrated by the cytological examination of material received. Inoculation experiments with different strains of the rust fungus have confirmed the results obtained in 1935.

Rose Mildew, *Sphaerotheca pannosa*, has been controlled successfully under commercial conditions by the use of a copper in oil fungicide.

The problem of cucumber root rot has been studied. A large number of fungi and bacteria have been isolated and are being tested for pathogenicity. Preliminary experiments suggest that infection may be carried in the horse manure used in preparing the beds.

A serious disease of mushroom beds occurred in the experimental house, having been introduced in imported soil used for casing certain sections. This proved to be the truffle, *Pseudobalsamia microspora*, which had been recorded in America but not previously in this country. The occurrence of this fungus emphasises the importance of sterilizing the casing soil.

A new eelworm disease of the tomato was also recorded. Galls are formed on the stems and leaf petioles, following infection by *Anguillulina dipsaci*, the stem and bulb eelworm. Inoculations with eelworms taken from diseased narcissus bulbs have shewn that they may serve as a source of infection to the tomato.

A good deal of attention has been given to diseases of flowering plants. These include a wilt of *Verbena* and *Solanum Capsicastrum* caused by *Phytophthora parasitica*, wilt of marguerite caused by *P. cryptogea*; leaf spot and mildew of hydrangea caused by *Botrytis cinerea* and *Oidium Hortensiæ*, and grey mould of *Statice* caused by *Botrytis cinerea*. The wilt of *Crassula falcata* is being investigated.

A second species of *Phytophthora* was isolated from wilted plants of *Erica hyemalis*. This fungus is being compared with *P. Cinnamomi*, originally established as the cause of wilt disease of cultivated heaths. Preliminary experiments suggest that this fungus is less virulent than *P. Cinnamomi*.

Although numerous enquiries regarding virus diseases continue to be dealt with, and several virus diseases were noted for the first time at Cheshunt, no new virus was recorded on tomato and cucumber during 1936.

Work was continued on the two tomato diseases, for which the name "Bushy Stunt" and "Enation Mosaic" have been proposed, and a method which facilitates the detection of the virus of Spotted Wilt in chrysanthemums was evolved.

During recent years a good deal of damage has occurred on tomato fruits in some nurseries by the formation of curious circular marks on the surface, which greatly reduce the market value. Although somewhat similar to "stigmonose" caused by aphids feeding on the young fruits, the lesions are not the same and the cause is quite different. The injury occurs when spores of *Botrytis* germinate in drops of water on the surface of the fruit, and in view of the part played by water in the formation of the lesions it is proposed to call this type of blemish "Water-spot."

During 1936 an attempt has been made to improve previous methods used to study the movement of assimilates in the seedling tomato plant. This has been done to such an extent that it is now possible to obtain determinations of the percentage change in weight of each of the larger leaves of a seedling at the nine leaf stage with a probable error of about 1·5% when a sample of ten plants is used. These methods are now being used to study the movement of assimilates and of respirable material. Work is also being carried out on the effect of various factors, both enviromental and internal to the plant, on the form of the plant and on the position of the first

flower truss. The position has been found to vary with the time of year and changes have now been induced artificially.

A feature of the chemical work has been the increase in the number and variety of samples submitted for examination. The numbers have increased gradually in recent years, and during the present year analyses are more than double those made five years ago.

Several instances of plant injury suspected to be of virus origin proved to be the result of injudicious use of chlorate weed-killer; the dangers involved in the careless use of such preparations must again be emphasised.

Preliminary analyses have been made on manure to be used for mushroom beds in the hope that some simple method might be found to determine when the manure is ready for use. The results are given in the report and the only conclusion to be made at present is that ammonia is produced only at the surface of the heap. Ammonia production is high immediately after turning and appears to fall and sometimes cease just before the heap is ready for the next turning.

DIRECTOR'S REPORT.

1. Experimental Results of 1936.

1. Tomatoes.

The tomato season of 1936 will be remembered for the lateness of the early crop and the smallness of the top fruit.

The weather following planting was dull and warm, with the result that the plants in general made a good deal of foliage and possessed thick stems. Setting did not offer any great difficulty, but the fruit developed slowly and ripened late. With the early planted crops root rot was a common feature, but heavy crops have been grown on many nurseries, particularly those planted from the middle of March onwards.

Watering offered a good deal of difficulty, because when the first real watering was commenced the night temperatures were low. This meant that the plants were not taking up water very quickly from the soil and in consequence heavy watering caused root rot because the soil remained wet and cold too long. The season's lesson is that heavy watering is dangerous, especially early in the season. It suggests that light waterings given frequently are better than heavy soakings at longer intervals.

The practice of grading the tomato fruits from the experimental plots adopted in 1921 was continued.

A.—"Pinks" number 5 to 7 and "Pink and White" 8 to 10 to the lb. These are the best quality of fruit in size, shape, and colour; "Pinks" being slightly larger than "Pink and Whites."

B.—"Whites." These fruits are of good colour but smaller than "Pink and White."

C.—"Blues." This grade consists of fruits of good colour but larger and more irregular in shape than Grade A.

D.—"Roughs." Small mis-shapen fruits about the size of cherries.

E.—Blotchy fruits which ripen irregularly.

F.—Fruits shewing Blossom End Rot.

G.—Fruits shewing the lesions of Stripe Disease.

H.—Fruits shewing "Green Back."

Figure 1.

Root Restriction Development.

8 A	9 F
7 C	10 D
6 D	11 A
5 B	12 E
4 D	13 D
3 B	14 C
2 C	15 15
1 A	16 A

A=10-inch Pots.
B=Wooden Boxes.
C=Cardboard Boxes.
D=Controls in the Ground.
E=Galvanised Pails.
F=Wooden Troughs.

(a) House 1. Root restriction experiments.

A crop of mint was forced during the winter in this house and it was not possible to plant tomatoes until March 30th, so that the value of the experiment was reduced to some extent. The soil was thoroughly dug after removing the mint roots, limed and manured. The soil of the house was then used for filling the containers in which the plants were to be grown. The house was divided into sixteen plots and the treatments arranged so that the results could be examined statistically.

In four control plots the plants were grown in the ground in the usual manner. In four plots the plants were grown in 10 inch pots, in three plots in cardboard boxes 8 inches by 8 inches by 10 inches, and in three others wooden butter-boxes 12 inches by 12 inches by 12 inches were used. In one plot the plants were planted out in galvanized pails having a hole 2 inches wide in the bottom. In another plot wooden troughs were used. The plot arrangement is shewn in Fig. 1 and the results in Table 1.

The experiments have been most instructive. The plants in pots were on the whole better balanced than the others. Next in order came those in cardboard containers, but there was little difference between those in the large wooden boxes and those in the ground. In both, the roots spread widely through the soil, and the early growth was more luxuriant than in the pots or cardboard containers. The crop was earliest in the pots and the quality of the fruits superior to all others.

Statistical examination of the results by Mr. Yates, of Rothamsted Experimental Station, shewed a standard error per plot of approximately 8% of the mean yield, and that the weight in tons per acre was approximately the same for each treatment.

Although the average weight is satisfactory it might have been considerably greater if the physical state of the soil in the containers had been more suitable.

The soil of the house was too heavy and held water too long to be satisfactory for this type of work. As it did not dry out quickly the plants could not be fed as often as was deemed necessary.

It seems safe to assume that a more sandy soil than the type used would yield better results, and this will be tested in 1937 when the plants will be planted out early in February.

The results suggest that short early crops may be grown satisfactorily in pots even in districts like the Lea Valley, because it is possible to limit the nitrogen supply and so keep the carbohydrate-nitrogen ratio nearer the ideal than is possible when plants are grown in the ground.

Table 1.

Variety—"Ailsa Craig."

House	Plot	Treatment	CROP YIELD IN TONS PER ACRE					
			June	July	Aug.	Sept.	Oct.	Total
1	1	Planted in 12″ Pots	8.78	23.65	14.88	8.84	4.07	60.02
	8	,, ,, ,, ,, ...	1.36	17.60	13.27	7.51	5.37	45.11
	11	,, ,, ,, ,, ...	3.38	17.60	13.33	7.29	3.23	44.83
	16	,, ,, ,, ,, ...	6.93	15.52	11.92	7.23	3.67	45.27
	2	,, ,, Cardboard Boxes	5.63	20.36	12.36	6.94	2.02	47.31
	9	,, ,, ,, ,, ...	2.20	21.37	13.04	6.85	3.47	46.93
	14	,, ,, ,, ,, ...	3.92	19.00	11.09	5.02	3.02	42.05
	3	,, ,, Wooden Boxes	4.85	21.46	10.55	7.06	1.97	45.89
	5	,, ,, ,, ,, ...	4.75	19.67	11.06	6.83	3.56	45.87
	15	,, ,, ,, ,, ...	4.31	21.33	10.25	5.72	2.60	44.21
	9	,, ,, Troughs	1.46	13.34	10.85	6.31	4.21	36.17
	12	,, ,, Pails	4.39	15.32	11.03	7.16	3.00	40.90
	4	Control in Ground	4.28	21.92	12.39	6.48	2.33	47.40
	6	,, ,, ,, ...	2.63	21.68	12.82	5.80	2.90	45.83
	10	,, ,, ,, ...	2.16	19.35	11.58	8.43	3.23	44.75
	13	,, ,, ,, ...	4.54	19.35	10.00	5.55	2.77	42.21

(b) Houses 3 and 4. Distance of planting.

In this experiment an attempt was made to see if wider planting than usual will improve the quality of the fruit and affect the yield per acre.

Two blocks of four plots were laid down in house 3 and one block in the south half of house 4. Each block contained four plots in which different planting distances were employed. In the control plot of each block of four, plants were set out in double rows 18 inches apart, with a path 27 inches wide between the double rows. The plants were 14 inches apart. The second plot was similar except for the fact that the plants were spaced 18 inches apart in the rows. In the third plot single rows 27 inches apart were used, the plants being 14 inches apart in the row. In the last plot the method was similar to the third plot, but the plants were 18 inches apart in the row. The arrangement of plots is shewn in Fig. 2 and the results in Table 2.

Statistical examination of the results indicate that the yield in tons per acre was practically the same with the different methods of planting. Thus, within the limits of the experiment, the yield per plant increased as the amount of space allowed to each plant was increased.

An attempt was made to determine the quality of the fruit in the different plots, but the variation was so great that it seems unwise to make a definite statement at this stage of the investigation. The fruit seemed larger with the wider spacing, and obviously it became easier to apply insecticidal and fungicidal sprays. The experiment will be repeated.

(c) Houses 7 to 10. Soil warming versus soil sterilization.

A severe attack of the tomato root eelworm developed in houses 7 and 8 during 1935. Some damage was also apparent in house 9 but house 10 remained clean.

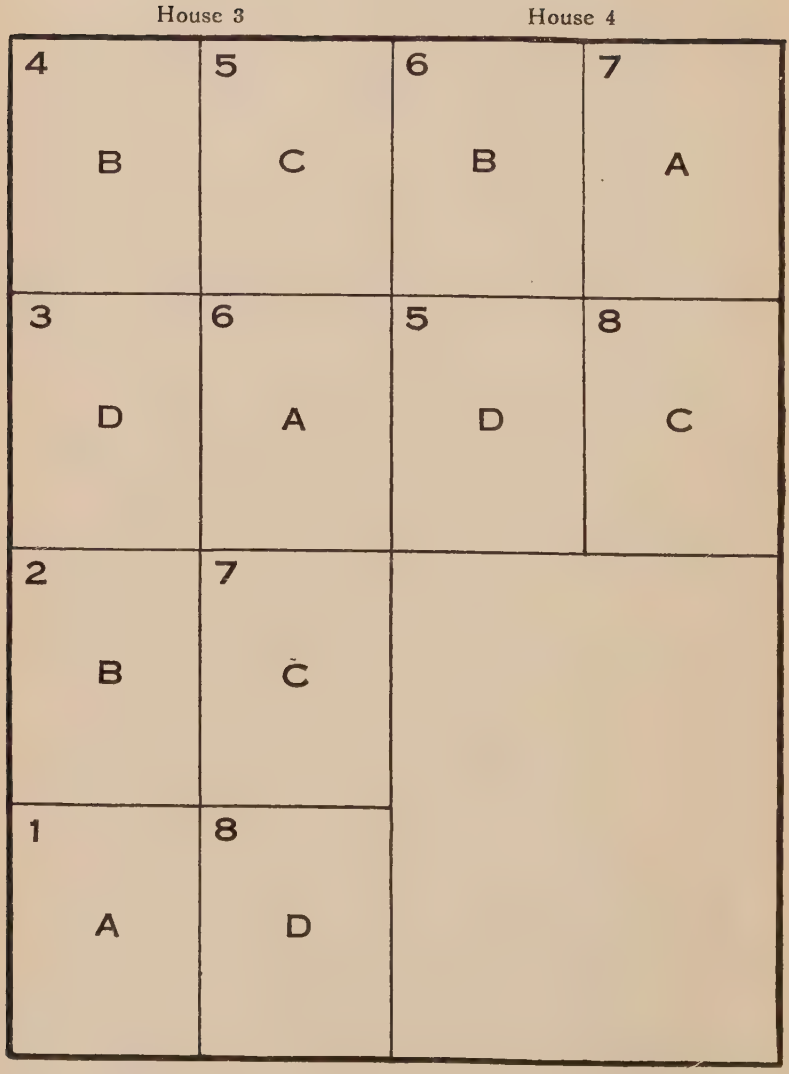
For the 1936 crop the soil in house 7 was steam sterilized by the "Hoddesdon pipe system."

Houses 8 and 9, where the soil warming apparatus is installed, were treated with a proprietary soil sterilizer of the carbolic type, except for plots 4 and 5 to which was applied a special product recommended especially by the manufacturers for destroying eelworm in the soil. House 10 was untreated except for plots 5 and 7 to which were applied a quantity of tomato haulms originally infected with *Verticillium albo-atrum* and then decomposed by the ADCO process.

House 7 gave a yield of 59·85 tons per acre, and when the roots were removed they were clean and free from any infection by eelworm, thus confirming the efficiency of steaming as a means of eradicating this pest in the soil.

Figure 2.

Planting Experiment.



A = Rows 18-in. and 27-in.; plants 14-in. apart in rows.
B = ,, 18 ,, ,, 27 ,, ,, 18 ,, ,, ,, ,,
C = ,, 27 ,, apart; plants 14-in. apart in rows.
D = ,, 27 ,, ,, ,, 18 ,, ,, ,, ,,

Variety—"Ailsa Craig."

Table 2.

House	Plot	PLANTING DISTANCES		CROP YIELD IN TONS PER ACRE						Grades				
		Between Rows	Between Plants	June	July	Aug.	Sept.	Oct.	Total	A	B	C	D	E
3	1	18″ & 27″	14″	12.29	16.01	8.96	5.77	4.06	47.09	54	14	21	4	7
3	6	,, ,,	,,	9.82	17.13	7.92	3.78	2.77	41.42	47	16	17	5	14
4	7	,, ,,	,,	9.06	16.91	8.63	4.65	1.67	40.92	54	16	17	5	6
3	2	18″ & 27″	18″	9.15	16.68	7.81	5.42	4.38	43.44	53	11	22	3	11
3	4	,, ,,	,,	6.11	19.33	8.82	6.63	2.89	43.78	58	10	22	3	6
4	6	,, ,,	,,	11.11	17.66	10.32	5.10	2.61	46.80	49	15	22	5	8
3	5	27″	14″	8.34	19.20	8.03	5.16	1.73	42.46	49	14	21	4	10
3	7	,,	,,	11.18	15.49	7.84	3.86	2.28	40.65	48	14	18	4	14
4	8	,,	,,	12.87	18.28	7.76	4.57	1.89	45.37	51	16	19	5	9
3	3	27″	18″	7.87	18.37	8.21	5.06	3.61	43.12	52	8	26	4	9
3	8	,,	,,	10.85	18.90	10.19	3.39	3.33	48.66	52	7	28	3	9
4	5	,,	,,	10.33	15.00	7.37	4.93	2.40	40.03	46	13	26	5	10

In house 8, where the soil was sterilized chemically with a carbolic preparation, the plants were planted at a soil temperature of 60°F. and allowed to set two trusses before raising the soil temperature by five degrees each day to a temperature of 80°F., at which it was maintained for twelve weeks. The yield was 59·05 tons per acre, which is almost the same as that from the steam sterilized house No. 7.

The other preparation, however, which was applied to plots 4 and 5 resulted in the lower average yield of 50·83 tons per acre.

In house 9, the young plants were kept longer in the pots before planting into soil at a temperature of 80°F., also maintained for twelve weeks.

In plots 1—4, the plants were kept in the size 60 pots and fed systematically until the first truss was formed and the first two flowers set. By design this was continued longer than seemed necessary to determine if injury could be caused in this way. The yield was 52·47 tons per acre. In plots 5—8 the plants were taken from the size 60 pots into size 32 pots and kept there until most of the fruit on the bottom truss had formed, when the plants were transplanted into permanent quarters. The yield amounted to 52·3 tons per acre.

Although the yield from house 9 is less than that from house 8, the experiment will be repeated in 1937, in an attempt to improve upon the treatment of the young plants before planting.

The experiments in houses 8 and 9 were undertaken to see if the soft growth which often occurs in warmed soil could be prevented. The method employed in house 8 of planting in soil at 60°F. and setting two trusses before raising the soil temperature to 80°F. was completely successful, since the swelling of the fruit checked the tendency to softness which might be anticipated following watering. On the other hand one of the benefits of soil warming is protection against *Verticillium* wilt, which is withheld during the period between planting and raising the soil temperature. Such protection is provided by planting larger plants in soil at 80°F. and, therefore, this system must be investigated further.

At present, however, the process of delaying the soil warming until two trusses have set can be recommended to those who are testing soil warming on a commercial scale, but only if the soil is free from the fungus *Verticillium*. Where *Verticillium* wilt has occurred previously, growers would be wise to plant in warm soil, using plants with the first truss nicely forward.

In house 10, the control plots 1—4 gave an average yield of 47·88 tons per acre, which is considerably lower than that from the steamed house and the best of the two soil warmed houses; the yield from houses 7 and 8 being approximately 25% higher than the control plots in house 10.

Plots 5—8 in house 10 were used to determine if diseased tomato haulms are sterilized when fermentated by the ADCO process.

One ton of tomato haulms heavily infected with *Verticillium albo-atrum* was treated with ADCO compound, thoroughly wetted and allowed to ferment. Fermentation did not proceed satisfactorily because the smallness of the heap allowed the heat to be eliminated quickly and the material became very dry on the outside. After four weeks the material was placed in large concrete tanks and the temperature rose quickly to 140°F. in most parts where a thermometer could be inserted. Three months later the compost was incorporated with the soil in plots 5 and 7 at the rate of 30 tons per acre. The material was examined in the laboratory and *Verticillium* was isolated from all the portions of stem which had not broken down to a fine flaky state. In the houses the plants quickly developed signs of *Verticillium* wilt and by the middle of July most plants were dead.

The experiment clearly emphasises the danger of incorporating infected material in the soil, and also indicates the difficulty of sterilizing infected material by the process of fermentation, which is perhaps due to the fact that the temperature within large pieces of stem, etc., is much less than that recorded at the surface by a thermometer inserted into the mass.

(d) Variety trials.

The variety trials were continued, results being given in Table 4.

The F_3 generations of Blaby—Kondine Red crosses, together with "J.H. No. 1," headed the list of crop yields, but the quality of the fruit was not so good as that of Radio and Ailsa Craig which came lower down the list.

Attempts to produce good cropping varieties resistant to tomato leaf mould have been continued. The latest selections are a considerable improvement on those of previous years, particularly the strain E.S.1 × Up-to-date × Potentate and E.S.1 × Up-to-date × Radio. Both of these produced five splendid bottom trusses of good quality fruit.

The plants were not "stopped," and as late growth was weak the top crop was not satisfactory. Next year the plants will be "stopped" at the fifth truss, and it is hoped to increase the total crop in this way.

The work promises to yield important results. Details are given in Table 5.

Table 3.

Variety—E.S. 1.

House	Plot	Treatment	CROP YIELD IN LBS. PER PLANT						Total Tons Per Acre	Average Tons Per Acre
			June	July	Aug.	Sept.	Oct.	Total		
7	1	Steam sterilised	0.84	3.49	2.02	1.59	0.46	8.40	63.82	59.85
	2	,, ,, ...	0.81	3.77	1.93	1.72	0.32	8.55	64.98	
	3	,, ,, ...	0.79	3.61	1.91	1.63	0.40	8.34	63.45	
	4	,, ,, ...	0.76	3.96	2.03	1.71	0.52	8.98	68.23	
	5	,, ,, ...	0.83	3.31	1.43	1.68	0.52	7.77	59.05	
	6	,, ,, ...	0.85	3.06	1.80	1.52	0.43	6.66	50.60	
	7	,, ,, ...	0.79	2.83	1.55	1.63	0.28	7.08	53.81	
	8	,, ,, ...	0.75	2.77	1.81	1.53	0.36	7.22	54.87	
8	1	Sterilized with a carbolic preparation. Plants planted out in soil at 60° F. Soil temperature raised gradually to 80° F. after the first two trusses had set and maintained there for twelve weeks	1.18	2.67	1.79	1.53	0.50	7.69	58.28	59.05
	2	,, ,, ,, ,, ,, ,,	1.15	2.72	1.80	1.95	0.51	8.13	61.79	
	3	,, ,, ,, ,, ,, ,,	1.05	2.65	1.64	1.43	0.48	7.25	55.10	
	6	,, ,, ,, ,, ,, ,,	1.03	3.13	1.92	1.33	0.62	7.93	60.26	
	7	,, ,, ,, ,, ,, ,,	1.13	2.76	1.75	1.39	0.54	7.57	57.53	
	8	,, ,, ,, ,, ,, ,,	1.03	2.99	2.02	1.64	0.40	8.08	61.38	
	4	Treated with preparation recommended for destroying eelworms	0.73	2.14	1.33	1.33	0.49	6.02	45.73	50.83
	5	,, ,, ,, ,, ,, ,,	0.69	3.09	1.70	1.38	0.50	7.36	55.93	

Table 3 *(continued.)*

House	Plot	Treatment	CROP YIELD IN LBS. PER PLANT						Total Tons Per Acre	Average Tons Per Acre
			June	July	Aug.	Sept.	Oct.	Total		
9	1	Plants in soil at 80° F. from size 60 pots : 1st flower set	0.39	2.32	2.00	1.51	0.72	6.94	52.74	
	2	,, ,, ,, ,, ,, ,,	0.40	2.44	1.95	1.34	0.79	6.93	52.57	
	3	,, ,, ,, ,, ,, ,,	0.34	2.65	1.91	1.34	0.77	7.01	53.29	52.47
	4	,, ,, ,, ,, ,, ,,	0.28	2.45	1.93	1.40	0.69	6.75	51.29	
	5	Planted in soil at 80° F. from size 32 pots : some fruit formed	0.34	2.76	1.72	1.26	0.52	6.60	50.14	
	6	,, ,, ,, ,, ,, ,,	0.42	2.58	2.24	1.17	0.68	7.09	53.88	52.31
	7	,, ,, ,, ,, ,, ,,	0.51	2.50	1.83	1.37	0.53	6.74	51.20	
	8	,, ,, ,, ,, ,, ,,	0.67	2.56	1.87	1.53	0.48	7.11	54.04	
10	1	Control	0.57	2.57	1.42	1.83	—	5.39	40.96	
	2	,, ...	0.53	2.72	1.69	2.33	—	6.17	46.89	47.88
	3	,, ...	0.37	3.00	1.69	2.21	—	6.27	47.65	
	4	,, ...	1.00	3.23	1.86	2.18	—	7.37	56.01	
	5	Diseased Tomato Haulm fermented by ADCO process added	0.13	1.09	—	—	—	1.22	9.27	
	7	,, ,, ,, ,, ,, ,,	0.63	1.70	—	—	—	2.33	17.71	13.49
	6	Control	0.36	1.99	1.02	—	—	3.37	25.61	
	8	,, ...	0.59	3.07	0.83	—	—	4.49	34.12	29.87

Variety Trials.

Table 4.

Variety	CROP YIELD IN LBS. PER PLANT						Total Tons per Acre	Quality of Fruit: Percentage in Grade.				
	May	June	July	Aug.	Sept.	Total		A	B	C	D	E
Blaby × Potentate F_3	—	1.88	1.82	1.09	0.75	5.54	42.10	16	5	68	4	7
Blaby × Kondine Red F_3	0.01	2.01	1.75	0.83	0.80	5.40	41.04	20	6	62	5	6
"J.H." No. 1	—	1.17	2.33	1.00	0.90	5.40	41.04	22	4	61	4	9
Early Market	—	0.94	2.57	1.05	0.67	5.23	39.75	51	14	25	7	3
Satisfaction	—	0.82	2.89	0.88	0.61	5.20	39.52	17	11	64	5	2
Radio	—	1.02	2.36	0.79	0.84	5.01	38.07	37	16	36	8	3
Ailsa Craig	—	0.58	2.19	1.22	0.95	4.94	37.54	29	11	48	5	4
Ailsa Craig × Blaby	—	0.89	2.39	0.85	0.77	4.90	37.24	59	18	12	7	4
Bides Recruit × Kondine Red	—	0.27	2.83	0.99	0.80	4.89	37.16	59	21	10	7	2
Aldouri	—	1.07	2.39	0.86	0.56	4.88	37.09	53	17	20	6	3
Bides Recruit	—	0.80	2.50	0.92	0.63	4.85	36.86	57	23	11	5	3
Potentate	—	0.94	2.37	0.96	0.56	4.83	36.71	20	6	68	3	3
Best of All	—	0.98	2.14	0.88	0.78	4.78	36.33	22	9	57	6	5

Leaf Mould Resistant Types.

Table 5.

Variety	CROP YIELD IN LBS. PER PLANT						Total Tons per Acre	Quality of Fruit: Percentage in Grade.				
	June	July	Aug.	Sept.	Oct.	Total		A	B	C	D	E
Stirling Castle × E.S.1 × Kondine... ...	0.75	2.06	1.11	0.83	0.10	4.85	36.79	57	14	10	7	12
,, ,, × E.S.1 × Radio	0.88	2.09	0.62	0.62	0.16	4.27	32.44	70	17	6	4	3
,, ,, × E.S.1 × Potentate ...	0.69	1.80	0.68	0.49	0.14	4.10	31.15	40	12	33	5	8
E.S.1 × Up-to-date × Potentate	1.09	1.49	0.74	0.48	0.13	3.92	29.79	59	14	20	4	3
,, ,, ,, × Radio	1.05	1.50	0.64	0.47	0.16	3.84	29.18	65	18	8	5	4
Stirling Castle × E.S.1 × Bides Recruit ...	0.66	2.05	0.59	0.39	0.14	3.81	28.95	53	27	6	9	5
Stirling Castle × E.S.1	0.37	1.81	0.57	0.43	0.09	3.27	24.85	54	27	5	8	4

(e) Winter tomatoes.

An attempt was made to produce a crop of tomatoes in size 32 pots for marketing late February or early March. It was only defeated by the long spells of dull weather which occurred in Cheshunt during the period November to January.

Seeds of E.S.1 were sown in normal compost about the middle of August, and when ready were planted in size 60 pots, using a poor soil low in nitrogen. Fertilisers were not added.

An attempt was made to grow the plants steadily without any signs of a check, and when they had produced a good supply of roots they were potted in size 32 pots, using the same poor soil.

During the second week in November, when light intensity became very low, the plants were taken from the propagating house and stood on the floor of a tomato house. They were staked, tied, and set out with the pots about 6 inches apart in staggered rows, a path 18 inches wide being left between each block of four rows.

The temperature was maintained by thermostat at 50°F. and water was given once every six weeks. The plants grew slowly, most of the flowers set and produced small fruit which swelled very slowly. They were stopped at the second truss and all side shoots removed. The lower leaves turned yellow through nitrogen starvation, and when this became severe the plants were fed lightly with a mixture consisting of one part sulphate of ammonia, one part nitrate of potash, and three parts superphosphate.

By the middle of January the light improved and half the plants were planted in the soil of a glasshouse, while half were left on the surface as before and fed with gradually increasing amounts of the mixture to which three parts of dried blood was added.

The temperature was raised to 60°F. and normal treatment applied. The fruits swelled to about the size of a golf ball, ripened, and were picked during the last week in February. When some were cut open they proved to be seedless although shape and colour were good. The fruit were too small for market and, therefore, the attempt failed, but it seems probable that in districts where the light intensity is better than in Cheshunt this method would prove successful. About 30,000 plants can be grown per acre in this way and a successful crop should be valuable.

The important details of the method are the use of soil low in nitrogen, a temperature of 50°F., and reduction of watering to a minimum. Future work may suggest alterations in the method, but the idea seems worthy of trial by growers.

(f) The use of peat in tomato soils.

Previous recommendations regarding the use of peat in tomato houses have been followed by commercial growers with considerable success. Its application during the middle of the year as a rooting medium placed in a thin layer on the soil surface has become the most popular, but many growers have tested the other method of mixing 20 to 25 tons per acre with the top 10 inches of soil before planting.

The following results by the second method were obtained by Mr. C. W. Mayhew, Northumberland County Horticultural Instructor at East Heddon Horticultural Station in 1936: —

	Farmyard manure in tons per acre.	Peat in tons per acre.	Yield of tomatoes in tons per acre.
Series 1	27	0	20·6
„ 2	27	22	27·1
„ 3	40	0	21·4

These results indicate the value of mixing peat with the soil before planting, and also confirm the fact that it is useless to increase the amount of manure applied if the physical condition of the soil is not suitable for satisfactory root development.

Mr. Mayhew's co-operation in this experiment is greatly appreciated, and the help of County Officers will be welcomed.

2. Cucumbers.

The cucumber experiments were chiefly concerned with the effect of irradiation of the plants during the propagation stages.

Four treatments were given, namely, high light intensity morning and evening, and low light intensity morning and evening. In the high light intensity series the plants were exposed to an intensity of 280 foot candles, while the low light intensity was 70 foot candles. The morning application was made from 3 a.m. to 7 a.m. and the evening application from 4 p.m. to 8 p.m.

As in previous years the source of illumination was a 500 watt gas-filled lamp with a parabolic reflector.

The plants reacted well to the light treatment. The best plants were those exposed to the higher light intensity, but even those receiving the lower light intensity were much better than the controls.

Planting in the borders took place on 7th February, and within three weeks the untreated plants had caught up with the controls.

Table 6.

Variety—"Butcher's Disease Resister."

H'se	Plot	Treatment	CROP YIELD IN LBS. PER PLANT							Total	Total Tons per Acre	Total Flats per Foot
			Mar.	Apr.	May	June	July	Aug.	Sept.			
C	1	Delicacy × Butchers F_2	1.84	11.22	8.22	9.68	8.86	2.73	—	42.55	63.83	1.29
	2	,, ,, ,, F_3	1.26	11.18	10.13	10.06	11.09	2.87	—	46.59	69.88	1.41
	3	,, ,, ,, F_3	0.88	9.36	5.82	10.42	14.92	3.86	—	45.26	67.89	1.37
	4	,, ,, ,, F_1 × Butchers ...	1.02	9.82	10.26	10.66	8.52	2.48	—	42.76	64.14	1.30
	5	,, ,, ,, F_1 × Butchers ...	2.11	10.34	9.72	9.24	8.34	2.19	—	41.94	62.91	1.27
D	1*a*	Soil 3 parts, Peat 1	1.50	6.60	6.82	5.50	5.05	1.22	—	26.69	40.03	0.81
	1*b*	Ordinary Compost	1.72	6.97	5.87	5.45	6.00	1.87	—	27.88	41.82	0.84
	1*c*	Soil 3 parts, Peat 1 part, Bone Meal 3 parts, Hoof and Horn 2 parts, Sulphate of Potash 1 part	0.75	8.37	7.47	7.22	4.72	1.03	—	29.56	44.34	0.89
	8*d*	Soil 3 parts, Peat 1 part, Hoof and Horn 2 parts, Sulphate of Potash 1 part ...	0.90	7.07	8.31	8.73	6.63	1.95	—	33.59	50.38	1.02
	8*e*	Soil 3 parts, Peat 1 part, Bone Meal 3 parts, Hoof and Horn 2 parts ...	2.13	7.70	8.05	8.20	4.75	1.47	—	32.30	48.45	0.98
	8*f*	Soil 3 parts, Peat 1 part, Bone Meal 3 parts, Sulphate of Potash 1 part ...	0.87	7.25	7.17	6.35	5.40	2.30	—	29.34	44.01	0.89
	7	Control	2.33	11.44	9.89	9.12	7.42	2.36	—	42.56	63.84	1.29
E	3	,, ...	2.07	11.05	9.32	9.87	10.42	2.35	—	45.08	67.62	1.37
F	5	,, ...	0.82	9.86	8.77	11.14	9.67	3.42	—	43.68	65.52	1.33
G	3	,, ...	3.68	13.90	8.68	15.88	8.77	4.73	—	55.64	83.46	1.69
	4	,, ...	3.60	14.35	10.92	16.37	10.30	5.91	—	61.45	92.18	1.86
	7	,, ...	0.97	13.13	7.98	14.09	7.07	4.77	—	48.01	72.02	1.46
	8	,, ...	1.44	14.42	8.94	13.91	6.03	5.58	—	50.32	75.48	1.53

Table 6 *(continued).*

H'se	Plot	Treatment	CROP YIELD IN LBS. PER PLANT								Total Tons per Acre	Total Flats per Foot
			Mar.	Apr.	May	June	July	Aug.	Sept.	Total		
D	4	Propagated under Electric light : Treatment (*a*)*	2.82	11.90	9.56	11.33	12.19	3.44	—	51.24	76.86	1.55
E	8	" " " " "	1.72	11.35	10.43	9.03	7.60	2.15	—	42.28	63.42	1.28
F	7	" " " " "	1.36	11.05	8.34	9.49	7.28	2.53	—	40.05	60.08	1.21
D	5	" " " " (*b*)	2.68	11.76	8.75	8.03	8.55	2.88	—	42.65	63.98	1.29
E	2	" " " " "	3.38	11.21	10.80	9.65	10.37	3.39	—	48.80	73.20	1.48
F	3	" " " " "	1.75	12.03	9.65	11.23	9.47	3.97	—	48.10	72.15	1.46
D	6	" " " " (*c*)	3.87	12.00	9.16	8.82	7.76	2.61	—	44.22	66.33	1.34
E	4	" " " " "	7.06	12.52	9.84	10.56	11.00	2.72	—	53.70	80.55	1.63
	6	" " " " "	2.07	11.78	8.31	9.67	7.50	1.41	—	40.74	61.11	1.23
	7	" " " " "	2.12	11.53	9.02	8.37	5.62	1.17	—	37.83	56.74	1.15
F	1	" " " " "	2.55	12.77	10.12	13.09	10.07	3.36	—	51.96	77.94	1.57
	6	" " " " "	3.17	11.36	10.11	9.76	8.70	4.23	—	47.33	71.00	1.43
G	1	" " " " "	3.88	12.53	11.56	17.00	7.90	5.45	—	58.32	87.48	1.77
	2	" " " " "	4.15	12.16	9.36	13.22	7.58	6.22	—	52.69	79.04	1.60
D	2	" " " " (*d*)	2.98	11.96	9.73	9.78	8.88	3.44	—	46.77	70.15	1.42
	3	" " " " "	4.46	12.12	9.97	10.82	10.12	2.67	—	50.16	75.24	1.52
E	1	" " " " "	2.66	9.65	8.34	6.80	6.36	2.57	—	36.38	54.57	1.10
	5	" " " " "	2.09	11.41	8.08	8.47	10.30	2.61	—	42.96	64.44	1.30
F	2	" " " " "	1.64	11.92	8.74	10.05	7.36	3.62	—	43.33	65.00	1.31
	4	" " " " "	1.93	14.02	9.94	13.50	11.30	4.73	—	55.42	83.13	1.68
	8	" " " " "	3.14	12.00	9.82	10.62	7.52	3.62	—	46.72	70.08	1.42
G	5	" " " " "	4.90	13.84	8.33	13.75	9.70	5.17	—	55.69	83.54	1.69
	6	" " " " "	5.41	12.82	7.16	13.22	8.01	3.67	—	50.29	75.44	1.53

* Treatment (*a*) 70 foot Candles from 4 p.m.—8 p.m.
" (*b*) " " " " 3 a.m.—7 a.m.
" (*c*) 280 " " " 4 p.m.—8 p.m.
" (*d*) " " " " 3 a.m.—7 a.m

The total weights of fruit picked from the treated plants and the controls were approximately similar, but the plants treated with the higher light intensity produced a somewhat heavier crop in March than the others.

The result of two season's work on this problem suggests that the beneficial effect of applying additional light during the propagating stages is greatest with very early crops, and that the method is of little value to plants prepared for planting in permanent quarters after the end of January.

This will be tested further by growing an especially early crop in 1937.

A preliminary attempt was made in house D. to determine how the omission of nitrogen, phosphate, and potash respectively affects the cucumber. Wooden troughs with slate bottoms were stood above the soil of the house and filled with a mixture of three parts soil and one part peat. Hoof and horn, bone meal, and sulphate of potash were used as the source of the nutrients, and the effects of soil and peat alone, and ordinary compost were also tested. The crop yields from the various plots provided no information, but the quality of the fruit was distinctly poor where phosphates were omitted. A large proportion of crooks were produced. The experiment will be repeated on improved lines.

In house C. the breeding work was continued, in an attempt to evolve a good cropping strain with a short neck, but unfortunately the results have not fulfilled their early promise.

3. Lettuce.

(a) In glasshouses.

In the experimental houses Cheshunt Early Giant lettuce was grown for marketing both at Christmas and during late February. The crops were completely satisfactory, the variety proving both earlier and superior to Golden Ball and Green Frame. Each year special plants are lifted and grown for seed production, which is tested the following year. In this way it is hoped still further to improve the variety.

Plants were grown in plots, 1 to 3 and 12 to 14, in tomato house 4, where different nutrients have been omitted for many years and the soil is deficient in respect of the nutrient omitted.

The growth of lettuce was affected to a considerable extent as follows:—

(1) Good fully hearted lettuce free from blemish were taken from the complete artificial plot, the average weight being 6·4 ozs. per head.

Table 7.

Series	FERTILISER TREATMENT IN CWTS. PER ACRE								Other Treatment	Average Weight per Head in Ounces	Remarks
	Hoof and Horn	Bone Meal	Sulphate of Potash	Dried Blood	Nitrate of Soda	Fish Manure	Bacterised Peat	Peat			
1	5	5	5	—	—	—	—	—	Soil warmed to 60° F.	6.20	By far the best lettuce.
2	5	5	5	—	—	—	—	—	Soil not warmed	5.75	Good, but not so large as No. 1.
3	—	—	—	—	—	—	—	180	,, ,,	5.25	Inclined to be pale and slower to heart.
4	—	—	—	—	—	—	180	—	,, ,,	5.75	Good : hearted well.
5	—	5	—	—	—	—	—	—	,, ,,	6.00	Not so good as No. 2.
6	—	—	—	5	—	—	—	—	,, ,,	5.75	Failed to heart.
7	5	5	5	5	—	—	—	—	,, ,,	6.25	Good : better than No. 2.
8	5	5	5	—	5	—	—	—	,, ,,	5.75	Good : similar to No. 7.

(2) Heads from the plot deficient in phosphate were good, but the hearts were only half the size of those from the complete artificial plot. The heart leaves were less tightly packed. The average weight was 5·6 ozs.

(3) The heads from soil deficient in nitrogen were loose. The heads were about a quarter the size of those from the complete artificial plot, the heart leaves were loosely packed and there was a tendency to elongation of the stem. In other words the heads were "peaky." The average weight per head was 4·3 ozs.

(4) Considerable variation occurred in the soil which was deficient in potash. The most striking features were an exaggerated upward development of the plant, elongation of the stem and a crumpled distorted appearance of the leaves. The hearts were extremely loose and small. It was difficult to calculate the average weight per head owing to the extreme variation, but this was less than 3·5 ozs. and the heads were quite useless for human consumption.

The above results indicate that an adequate potash supply is most essential for lettuce. Nitrogen and phosphate are also necessary, but the former more so than the latter.

Seeds of Cheshunt Early Giant lettuce have been distributed in quantity all over the country and growers have testified to its excellence and suitability for autumn and winter work in glasshouses. Its cultivation is being developed on a large scale and growers are recommended to test it for themselves.

(b) In frames.

The production of lettuce and carrots in cold frames is being extended. The variety Cheshunt Early Ball, which was obtained during the preliminary work with Cheshunt Early Giant, is proving as useful for frame work as the latter is for glasshouses. It gained the first prize in both 1935 and 1936 in the cold frame section at the Early Market Produce Show organised by the Royal Horticultural Society in Vincent Square, London. Seeds are now available for distribution and it is hoped that growers will test it.

The experiments conducted in the frames are detailed in Table 7. The seeds were sown on 18th November in tomato seed boxes, the seedlings being pricked off later and gradually hardened off in a cold tomato house for planting in the frames on 6th January.

The plants growing in soil warmed to 60°F. were by far the best of the crop. They were regular and possessed big hearts. The next best were those to which dried blood and nitrate of soda respectively were given, in addition to bone meal, hoof and horn, and sulphate of potash.

The most disappointing results occurred where the soil was given 5 cwts. of dried blood only per acre. The plants were large and loose. They failed to heart and were particularly susceptible to *Botrytis* rot.

The addition of peat only produced pale heads slow to heart, but the bacterised peat produced lettuce of good colour superior to the former. They were, however, not so good as those from the ordinary soil to which bone meal, hoof and horn, and sulphate of potash were added.

Further information on the effect of soil warming on the cultivation of plants in frames will be available in 1937, when the new soil warming experiments have passed the first season.

This experiment has been made possible by the gift of a large quantity of 1 inch pipes by Messrs. Stewart & Lloyd, to whom our grateful thanks are due.

The land was marked out into four equal sections, each 30 feet wide and 66 feet long, and soil warming apparatus was installed in three of them, leaving one unwarmed for control purposes.

Three inch flow-and-return headers were laid down in a trench running across the ends of the plots and thermostatic control valves were fitted for each plot. The positions of the frames were marked out and loops of 1 inch pipes were taken off the mains in such a manner that the soil under each frame would be heated by a single flow-and-return buried 18 inches below the surface. These pipes were 2 feet 6 inches apart.

It is planned to maintain soil temperatures of 55°, 60°, and 65° respectively, and to grow a fairly wide range of plants both in frames and in the open.

4. Mushrooms.

Through the generosity of the Ministry of Agriculture half the cost of a mushroom shed was provided for experimental purposes. In addition to this Mr. J. Harnett provided the boiler and hot water pipes, while Mr. Ben Rubenstein gave the cedar wood of which the shelves and their supports were constructed. Our grateful thanks are due to these donors for their generous gifts.

The shed, 40 feet long and 17 feet wide, was constructed in accordance with latest practice. The walls were formed of feather edge boards on the outside and closely fitting boards inside, with a central space filled with wood wool. The roof, covered with waterproof sheeting, rose to a ridge fitted with ventilating louvres. A flat ceiling of asbestos sheets was placed at a height of 9 feet 6 inches above a cement floor, and wooden shutters were placed in the ceiling immediately below the ridge for purposes of ventilation.

Two tiers of shelves were constructed between floor and ceiling, allowing a centre path and one on either side of the shed. The supports of cedar wood (4 inches × 3 inches) were placed 4 feet apart and joined with similar timber to support the boards forming the shelves, the shelves being 4 feet 6 inches wide. There were three shelves in each tier, the side and end boards of each shelf being 8 inches × 1 inch material. The bottom shelf was placed 12 inches above the floor, and between the bottom boards of the first and second shelves a space of 2 feet 6 inches was allowed. The second and third shelves were the same distance apart, but the bottom of the top shelf was 3 feet 4 inches below the ceiling. The greater space above the top bed is necessary owing to the relatively high temperature under the ceiling.

The first experiment started on 6th April when the prepared compost was taken into the shed.

The experiment was arranged to determine the effect, if any, of using different types of soil for casing the beds.

Four samples were obtained, namely, a moderately light soil from Hoddesdon, a heavy soil from Cheshunt Common, and two heavy soils from Worthing. Each soil was used for covering one of four equal areas in each shelf.

The results were most instructive. Six weeks after spawning the first flush of mushrooms appeared, first from the plots cased with the Cheshunt soil and then from the others almost simultaneously. Picking proceeded normally for the first sixteen days and then *Mycogyne* appeared in each plot cased with one of the soils and in no others. This was stopped quickly by removing the diseased clumps, taking out a little soil and manure below, dusting the hollow liberally with hydrated lime and filling up with new soil with which 33% of lime had been mixed.

The next trouble was much more serious. Mushrooms ceased to develop beyond the pin head stage in all the plots cased with another soil sample. Examination shewed the

damage to be due to the beds being infected with a species of truffle, *Pseudobalsamia microspora*, Diehl and Lambert. This is the first record of this disease in England, and was described by Williams in the "Gardeners' Chronicle," 22nd August, 1936. It is discussed fully later in this Report. The fungus grew in the casing soil and near the top of the compost to such an extent that further development of mushrooms practically ceased. In spite of all attempts to control it, the infection spread so rapidly through the beds that they had to be removed.

The experiments have been most valuable because they indicate that diseases of the mushroom crop can be carried in the casing soil, and in future sterilized soil only will be used for casing.

Further experiments concerning the question of casing soils will be arranged for the next crop.

5. The Heating of Glasshouses.

The latest addition to the heating apparatus in use at the Station are two new Ideal Magazine Boilers kindly installed by Ideal Boilers and Radiators, Ltd., to whom our grateful thanks are due. The boilers are of the gravity feed type with a sloping grate, designed for burning coke. Each has a rating of 517,200 B.T.Us. per hour, and the pair are being used to heat houses 7 to 10 and also the soil in the frame experiments.

Temperature control is by a thermostat placed in the glasshouses, which operates the dampers at the back of the boiler.

Since the time they were installed during the spring of 1936 they have given every satisfaction and are worth the consideration of every nurseryman.

2. Plant Diseases.

Prior to 1934 about 300 specimens of diseased plants were examined and reported on annually, but during the past two years the numbers have increased greatly and, in 1936, 446 specimens were examined.

Diseases not previously reported are listed below :—

Host	Disease	Cause
Almond	Leaf curl	*Taphrina deformans.*
Asparagus plumosus ...	Damping-off ...	*Rhizoctonia solani.*
Azalea	Gall	*Exobasidium rhododendri.*
Carnation	Rot of cuttings ...	*Fusarium avenaceum.*
French Bean	Halo-blight... ...	*Bacterium medicaginis* var. *phaseolicola.*
Hydrangea	Powdery mildew ...	*Oidium hortensiæ.*
Iris (bulbous)	Mosaic	*Virus.*
Lettuce	Mosaic	*Virus.*
Lilium longiflorum ...	Lily disease ...	*Botrytis elliptica.*
Marguerite	Foot rot	*Phytophthora cryptogea*
Mint	Rust	*Puccinia menthæ.*
Mushroom	Brown plaster mould	*Papulaspora byssina.*
Mushroom	Invader of beds ...	*Clitopilus cretatus.*
Mushroom	Invader of beds ...	*Pseudobalsamia microspora.*
Mushroom	Rose comb disease	Non-parasitic.
Mustard	Damping-off ...	*Rhizoctonia solani.*
Narcissus...	Mosaic	*Virus.*
Primula japonica ...	Mosaic	*Cucumber Virus 1.*
Potato	Stem canker ...	*Rhizoctonia solani.*
Pyrethrum	Leaf blotch... ...	*Aphelenchoides ritzema-bosi.*
Rose	Leaf spot	*Sphaceloma rosarum.*
Statice	Grey mould... ...	*Botrytis cinerea.*
Stock	Damping-off ...	*Rhizoctonia solani.*
Tomato	Stem gall	*Anguillulina dipsaci.*
Tulip	Topple	Non-parasitic.
Verbena	Foot rot	*Phytophthora parasitica.*
Violet	Leaf spot	*Alternaria violæ.*
Violet	Wilt	*Verticillium sp.*
Zinnia	Damping-off ...	*Rhizoctonia solani.*

1. Rose Rust.

P. H. Williams.

The rose rust investigations were continued during 1936 It proved impossible to maintain all the strains of rust alive during the winter of 1935—6. As the cold weather approaches the uredospores in the sori are progressively replaced by teleutospores until only a few, or none at all, are present. Conditions for infection are also very unfavourable during the winter, owing partly to low temperatures and partly to lack of foliage suitable for infection. Hence it becomes very difficult to keep the rust alive. The strains which infect the rose seem to be less susceptible in this respect than those which infect briars, and the problem of keeping these viable is made easier by the fact that the rose grows more freely during the winter than the briars and therefore there is a better supply of material for inoculation.

Of the briar strains, those on *R. canina*, Kokulinsky's *canina*, and Deegen's *canina* were recovered from stem infections in the spring. Cross inoculations with these strains on the briars previously used, and on the rose, confirmed the results described in the Twenty-First Annual Report.

Germination of teleutospores.

A supply of teleutospores on the rose was obtained through the courtesy of Mr. Courtney Page. The leaves were placed in a muslin bag and hung out-of-doors under shelter as in the previous autumn. They were tested for germination at intervals during April and May. Spores floated upon distilled water were observed to germinate on June 2nd. During previous years some spores in each germination experiment were placed on a dry slide in a moist atmosphere and became wetted by the water which condensed on the slide. None has ever been observed to germinate. It was thought that they might germinate under these conditions if still attached to the leaf, and therefore small pieces of leaf bearing teleutospores were cut out and placed upon the slides. No germination was observed.

Although it was not possible to repeat fully the germination experiments made in 1935, because the supply of spores was not sufficient for both germination and inoculation experiments, this experiment confirms previous findings that germination of the teleutospores occurs during May and June if the spores have been exposed to winter conditions. The fact that germination has only occurred when spores were floated on water suggests that wetting by rain may be necessary in nature to initiate germination.

Infection experiments.

As soon as germination of the teleutospores had been observed, the remainder of the leaves were used to inoculate rose plants. They were tied on the plants and also suspended above them in the moist chamber. They were then atomised with distilled water, and the moist chamber was kept closed for a week, after which the plants were placed in a glasshouse. No infection was obtained in this way.

During the course of this investigation many other attempts have been made each year to infect roses by means of the teleutospores. The methods employed have included tying the infected leaves on the plants, laying the leaves on the soil beneath, or spraying the plants with a suspension of the spores. Some plants so treated have been placed in a moist chamber for varying periods before being placed in the glasshouse. Others have been left for the whole period of the experiment under ordinary glasshouse conditions. In no case has any infection resulted.

The caeoma and uredospore stage on leaves.

That infection of the rose by the teleutospores does occur, however, is shown by the fact that leaves bearing the caeoma or aecidiospore stage, which is said to result from such infection, have been observed.

Microscopic examination of such leaves and of those bearing the uredospore stage show some striking differences. In the uredo sori the leaf tissue is not disorganised, except under the sorus where the hyphæ form a dense mass, although the mycelium of the fungus spreads some considerable distance beyond this disorganised portion. The spore-bearing hyphæ grow out from the mass of mycelium and rupture the epidermis of the leaf, there forming a dense tuft of hyphæ each one of which bears a single spore. The effect on the leaf is therefore quite local and only affects the lower surface.

In the caeoma the sorus is much larger and involves a comparatively large area of the leaf. The whole of the leaf tissue is disorganised and filled with a mass of mycelium. On the lower surface the epidermis is ruptured and breaks away, exposing a flat layer of cells which form a "hymenium." From this hymenium the aecidiospores are budded in chains. In some cases it seems as if aecidiospores as well were produced on the upper surface, but these structures are difficult to interpret. In other cases a close palisade tissue is formed under the upper epidermis, and from it structures are budded off which may be the "spermatia" formed by rusts at this stage.

The exact nature of the lesions formed on the stem has not yet been determined. Difficulty has been experienced in fixing the hard woody stems in such a manner that sectioning is easy, and during the past season material has not been sufficiently abundant for extensive experiments on this problem to be made.

Summary.

(1) Cross inoculations with strains of rose rust from briars and the rose have confirmed previous work.

(2) Germination of teleutospores has again been observed following their exposure to winter conditions.

(3) The results of infection experiments with teleutospores are reported.

(4) The caeoma and uredospore stages on rose leaves are described.

2. Control of Rose Mildew

(Sphaerotheca pannosa).

O. B. Orchard.

During the past three years small scale experiments have shewn that successful control of rose mildew may be obtained by the application of a copper-in-oil fungicide.

During the past season it has been possible to conduct large scale trials on glasshouse roses on a commercial nursery.

The fungicide, which may now be purchased as a proprietary combined fungicide-insecticide mixture,* was first applied at the end of June, and even under conditions of severe infestation the disease was readily controlled by applications at three weeks' intervals.

The mixture should be diluted in accordance with the maker's recommendations, which have been based on the results of experiments at this Station.

The use of this preparation appeared to improve growth, and was in no way detrimental to blooms when cut according to normal market practice. Slight spotting was caused on fully open blooms.

3. Cucumber Root Rot.

P. H. Williams.

During the winter of 1935—6 many growers lost large numbers of young cucumber plants either while they were still in the pots or just after planting in the beds. The

* Bouisol-White-Oil Emulsion.

symptoms consisted of a more or less severe decay of the tap and lateral roots. The disease appeared to commence at different points. In some cases the tip of the tap root was first affected, in others the rot appeared to start in the lateral roots and to pass from them into the tap root, while in many cases the tissues around the point of emergence of a lateral root turned yellow and appeared to be the starting point of the rot.

From similarly affected plants various fungi, such as *Fusarium* and *Phytophthora*, have been isolated in the past and the disease has been attributed to them. In addition to the fungi, bacteria have also appeared in the isolations. Nothing is known about the part these organisms play in the disease nor how far other factors, such as water conditions of the soil, etc., favour infection of both fungi and bacteria. In view of the increasing importance of this disease it was decided to investigate it carefully.

During the past year the work has been of a preliminary nature. A large number of isolations were made and the organisms obtained were separated in the appropriate manner. Bacterial cultures, after purification, were examined and compared, duplicates and cocci being rejected. Twenty-nine different bacteria have so far been selected for study. Forty different fungi have been obtained, many of them being strains of *Fusarium*, but it seems desirable to test their pathogenicity before rejecting the duplicates which are undoubtedly present. In addition ten cultures of Actinomyces have been isolated.

Eventually it is hoped to test all these organisms, and any others which may be isolated, by the method of direct inoculation. Difficulty was encountered in earlier work on tomato root rot in inoculating the roots of plants growing in soil and in keeping such roots free from contamination after inoculation. To overcome this difficulty, an attempt has been made to discover a suitable water culture solution in which healthy plants may be grown and the roots used for testing the pathogenicity of the organisms and determining those which are likely to be responsible for the decay.

In addition to the work outlined above, some experiments have been carried out to determine the possible sources of infection. Samples of turf and of the propagating and potting composts were obtained from a nursery on which the disease had been very severe. Corresponding mixtures of soil and manure were prepared from the materials used at the Station and were sterilised. Cucumbers were sown and potted in these mixtures and in various combinations of them. Rotting of the tap root and lateral roots only occurred in pots where

the mixtures contained manure from the infected nursery. Plants growing in the turf from this nursery remained healthy and the manure seemed to be the source of the infection. A number of isolations were made and in a large proportion of them *Fusarium* developed. In a later experiment, using mixtures of sterilized and unsterilized soil and manure in various combinations, some evidence was again obtained that the infection was carried in the manure although the amount of disease was much less than before. The amount of infection carried in the manure will doubtless vary with its source and with the conditions under which it is stored.

4. An Invader of Mushroom Beds new to Great Britain.

P. H. Williams.

During the mushroom experiments in 1936 certain beds were found to be invaded by a truffle fungus, *Pseudobalsamia microspora*. This fungus has not previously been recorded in Great Britain. It was first described by E. B. Lambert (Phytopathology XX., p. 917, 1930) from several localities of the United States, and it has since been recorded in Denmark.

The fungus grew in the casing soil and near the surface of the compost. It was at first confined to soil from one particular source but later spread throughout the bed. Without doubt the casing soil was the source of the infection.

The fungus forms a dense mat of coarse mycelial stands on which the fruiting bodies (ascocarps) are borne on short branches. The ascocarps are cream coloured to reddish brown, sub-spherical to discoid, and irregularly lobed. They vary in size from $\frac{1}{8}$ of an inch to 1 inch in diameter. A full description of this interesting fungus was published by W. W. Diehl and E. B. Lambert in Mycologia, XXII., p. 223, 1930.

Pseudobalsamia microspora acts rather as a competitor with the mushroom than as a parasite. It is reported as being especially serious in the case of slow growing crops. It has not yet been found in the field and nothing is known of its habits in the natural state. From the fact that it grows mainly in or near the surface of the mushroom bed, it may be inferred that in nature it grows mainly in the upper layers of the soil and is not likely to be present in the subsoil. If unsterilized soil from the second spit is used for casing, care should therefore be taken to avoid mixing any of the top spit with it. Still better is the practice of sterilizing all soil before use.

The chemical treatment of infected beds which are still cropping would seem to be out of the question. Prompt removal of the infected portions of the bed might possibly prevent the fungus from spreading. All infected soil and compost should be sterilized by heat or burned before disposing of it.

A short illustrated note on this fungus was published in the Gardeners' Chronicle, Vol. C., p. 147, 1936. Thanks are due to Miss E. M. Wakefield for kindly confirming the diagnosis of the fungus.

5. Experiments on the growth of *Oospora fimicola*, the White Plaster Mould of Mushroom Beds.

P. H. Williams.

During the past season this fungus, better known by its old name of *Monilia fimicola*, has caused severe injury in mushroom houses. An investigation of the factors which influence its growth has been commenced, and the results of certain experiments are here reported.

(a) The effect of the reaction of the medium.

The growth of *Oospora fimicola* on potato agar of varying acidity has been investigated. The acidity of the medium was altered to the desired degree by adding equal volumes of various mixtures of sodium phosphate and citric acid to double strength potato agar. The acidities obtained ranged from pH. 2·8—7·6.

The agar and solutions were sterilized separately and mixed just before pouring into the petri dishes. Two plates were poured at each acidity and the pH. of the medium was determined at the time of pouring. The plates were inoculated in the centre with a pure culture of the fungus and the diameter of the resulting colony was measured in two directions at right angles. The results, expressed as increase in diameter per day, are shewn in Table 1, and are thus the mean of four measurements.

Table 1.

Effect of acidity on the growth of *O. fimicola*.

pH.	Growth in m.m. per day.
2·8—4·6	Nil.
5·0	0·070
6·2	0·258
7·2	0·291
7·6	0·301

These figures show a very pronounced increase in the rate of growth of the fungus as the medium became more alkaline.

There is, however, the possibility of a direct effect on the fungus of either the phosphate or the citric acid. To investigate this further the experiment was repeated (Series C. below), and in addition other mixtures were used to produce changes in the acidity of the medium. The following substances were used :—

Series A. Sodium phosphate and potassium acid phosphate, pH. 4·8—7·6.
Series B. Sodium citrate and hydrochloric acid, pH. 3·0—3·9.
Series C. Sodium phosphate and citric acid, pH. 3·2—7·8.

There was no growth in Series B. The results in Series A. and C. expressed as before are given in Table 2.

Table 2.

	Growth per day.	
pH.	Series A.	Series C.
3·2—4·2	—	Nil.
4·8	0·113	—
5·0	—	0·050
5·4	0·115	—
6·0	0·093	0·241
7·0	—	0·274
7·0	0·202	—
7·8	—	0·251

Consideration of the actual concentrations of phosphate in Series A. and C. suggests that it has little direct effect on the growth of the fungus. Citric acid appears to be toxic in higher concentrations, but further experiments are necessary before coming to any definite conclusion.

(b) Growth on compost.

Samples of the manure used for mushroom beds at the Station were taken when it first arrived, and subsequently from the middle of the heap at each turning. At each sampling six 500 cc. conical flasks were two-thirds filled with the manure. Each flask was inoculated with a spore suspension of *Oospora fimicola* and the neck plugged with cotton wool. The plugs were covered with cellophane. The flasks were divided into three lots, one being incubated at 25°C., the second at 20°C., and the third at 15°C.

In the first sample the long straw was put in separate flasks from the fæces and short straw, but in subsequent samples no such separation was made.

A sample of the fresh manure was taken on 28th October. In the flasks containing the long straw a little *Oospora* was seen on 18th November at 20°C. and 15°C., but later it died out. Copious growth of *Coprinus* occurred on these samples. On the fæces from the same sample *Oospora* was also found at 15°C. on 18th November, but again it died out. Later samples gave the following results :—

11th November. No growth of *Oospora*.
17th November. No growth of *Oospora*.
23rd November. Slight growth at 25°C. and 15°C. on 18th December.
27th November. Abundant growth at all temperatures on 10th December.
1st December. Abundant growth at 25°C. and 20°C. by 18th December, when growth was starting at 15°C.

While these results cannot be regarded as conclusive, they suggest that the manure must be decomposed to a certain extent by composting before it is suitable for the growth of *Oospora*. This is in agreement with the opinion prevalent among growers of mushrooms.

6. Verticillium Wilt of the Perpetual Flowering Carnation.

H. L. White.

Control Measures.

In the Annual Report for 1935 it was stated that recommendations for the control of the disease would be distributed as a circular to Members. Since these circulars are not yet ready, references to this disease given in the Annual Report for 1934 and 1935 are supplemented here by notes on control measures.

Successful control of the disease is clearly dependent on (1) elimination of the causal organism from diseased beds, (2) prevention of re-infection. Methods which consist of the building up of fresh beds not in contact with old diseased soil must also be considered.

(a) Building up of new beds not in contact with old contaminated soil.

(1) Simple replacement of soil.

Replanting on diseased beds in which the top foot of soil has not been replaced is usually followed by the widespread appearance of disease symptoms within about four months. Replanting on diseased beds in which the top foot of soil has been replaced by fresh uncontaminated soil is usually followed

by the appearance of diseased symptoms in about ten to fourteen months. In commercial carnation culture the first six months after planting is an unproductive period devoted to forming the plant, and it is clear that simple replacement of the top soil is not worth further trial by growers owing to the probability of re-infection from the paths, sideboards, deep roots, and possibly the subsoil.

(2) Mechanical barrage.

A new bed of fresh uncontaminated soil may be separated from an old diseased bed by bricks or drain-pipes or by supporting the bed on a raised floor of boards or tiles. The penetrative capacity of the roots of a crop, which may retain position for three years, is considerable and it may well be doubted if the simple interposition of bricks or tiles would achieve its object. The necessity for drainage seems to preclude the use of cement. A "raised bench," separated from the floor of the house by a space, if filled with fresh uncontaminated soil and planted with clean stock, must secure at first a clean crop.

(3) Chemical barrage.

An alternative method of separation of a new bed from old and possibly disease-containing subsoil is the interposition of a chemical layer which will permit drainage but discourage penetration of the roots. A relatively inexpensive chemical for this purpose is lime. Such a method combined with sterilization or replacement of the top soil appears promising. The lime layer must be laid carefully so as to remain unbroken. A similar method has been used by a grower over a period of years for the control of eelworm in old tomato houses, and there does not appear to be any reason why this method should not be applied to the control of *Verticillium* wilt in carnation houses.

(b) Elimination of the causal organism from diseased beds.

(1) Application of fungicides to the soil.

The difficulty of penetrating portions of root containing the fungus and in obtaining intimate contact with the soil particles, even in the absence of a growing crop, suggests that any such method is not a feasible proposition on a commercial scale.

(2) Alternation of crops.

In comparative inoculation experiments *Verticillium cinerescens* has so far failed to attack plants other than carnations. The possibility of cleaning the soil by growing several successive crops of tomatoes must not be overlooked.

(3) Steam sterilization.

Steam sterilization has come to be regarded as a standard method of controlling certain soil diseases of the tomato and cucumber and there appears to be no reason why it should not also control *Verticillium* wilt of the carnation. There are many cases of the alleged failure of steam sterilization to control disease in tomato and cucumber houses which on investigation have been traceable to the use of the wrong method or its inefficient application. Similar cases of alleged failure of steam sterilization on carnation nurseries are not infrequent, and it must be emphasized that inefficient sterilization is worse than no sterilization, as the destruction of competing micro-organisms makes the soil a more fertile medium for the spread of disease. It is useless to sterilize the beds without also sterilizing the paths and the sideboards. It is useless to allow workers to sterilize beds without proper supervision, as they are liable each time the steaming apparatus is moved to step from the unsterilized to the sterilized portion of the house, carrying lumps of muddy soil on their boots and thus automatically and consistently re-infecting the supposedly sterilized soil. Recesses which are not conveniently treated by the steaming apparatus tend to be passed over by unsupervised workers.

Contamination of the subsoil has been alleged to be a contributory cause of the re-appearance of the disease after steam sterilization. Should subsoil contamination be proved to occur the situation appears to demand, not the rejection of steam sterilization, but the introduction of a method suited for steaming to a lower depth. It is difficult to see how any effective and permanent control of *Verticillium* wilt in carnation houses can be secured without the use of steam sterilization.

(c) Prevention of re-infection.

It is clearly useless to carry out efficient sterilization of diseased beds if sources of re-contamination are neglected. Since *Verticillium* does not normally fructify on the surface of dying plants infection from spores dispersed in the atmosphere is unlikely. Three important sources of re-infection must be considered.

(1) Cuttings.

Cuttings taken from infected plants have been proved to contain *Verticillium*, and it seems certain that a small proportion of these infected cuttings survive to carry the disease from the propagating house to the beds and so distribute the disease over the nursery. Stock in transit from nursery to nursery must be considered suspect. It seems probable that many infected cuttings would show wilt before reaching the stage of planting out and be discarded, but some, according to Wickens (1), retain the fungus in a semi-dormant condition for a lengthy period. In the absence of any method of bringing out the latent disease in these plants it would seem necessary, in order to obtain stock 100% clean, to grow a generation in pots for the special purpose of propagation to the exclusion of bloom. Such a procedure would scarcely be practical as a permanent method of commercial propagation, but might be undertaken for the purpose of cleaning stock, variety by variety. It should also be an essential precaution in the propagation of stock from new varieties introduced to the nursery.

(2) Water supply.

There is no evidence that a natural water supply is infected with the spores of *Verticillium cinerescens*. Lack of modern equipment and shortage of water may, however, lead to the retention of water-systems that cannot be justified from the point of view of disease control. Surface drainage is undesirable in a nursery water supply, and the drainage water from houses of diseased plants, which must be suspected of containing the pathogen, should be prevented from entering surface reservoirs that may thus become responsible for spreading the disease over the nursery. Underground reservoirs fed from streams or ditches that border the houses should be abolished.

(3) Infected tools.

On a nursery, visited by the writer, diseased areas first appeared about a year after planting the first crop on virgin soil in a newly-erected block. The fact that not a single diseased plant was observed during the first nine months after planting appears to preclude the possibility that these diseased areas arose from the planting of infected stock. Most of the diseased areas were at the edge and towards the end of the beds, and enquiry elicited that the plants had been hoed and watered with tools and hoses from an adjacent block with extensive disease. The rows of wiring placed over

carnation beds for the support of the plants necessitates continued laying of the hoses on the soil when watering, and it seems certain that disease is frequently spread from block to block by the carrying of contaminated soil on tools and hoses. The obvious remedy is to segregate the tools used for blocks that are free from disease.

REFERENCE

Wickens, S. M. (1935). Wilt, Stem-Rot, and Dieback of the Perpetual Flowering Carnation, Ann. Appl. Biol., XXII., 634—83.

7. Anther Smut of the Perpetual-Flowering Carnation.

That species of dianthus may contract the anther smut disease caused by *Ustilago violacea* (Pers) Fuck appears to have been first recorded in this country by Massee (J. R. Hort. Soc., 32, LXXXIII., 1907). During the present spring and summer the disease, present but not of outstanding importance hitherto on a carnation nursery near London, attained epidemic proportions. It was also recorded from other nurseries, and a brief description was published (Gard. Chron., III., 100 –254, 1936) bringing the main features of the disease to the attention of nurserymen. This article is known to have been responsible for the elimination of the disease from one nursery on which it was gaining a foothold.

The mycelium of the anther smut fungus ramifies within the tissues of the host but the damage caused is not extensive until the buds commence to develop. The stamens are then invaded and the pollen grains replaced by fungal spores. At this stage the buds open, the blossoms having the appearance of being sprinkled with a sooty violet-black dust. This dust consists of the smut spores of the fungus.

It does not appear to be possible to effect any cure once infection has occurred. Fortunately an infected plant is readily recognizable before the buds open and the latter can therefore be removed, thus preventing dispersal of the smut spores and subsequent spread of the disease. An infected flower-stalk is stunted and the developing bud is squat, *i.e.*, thick relative to its height; later there is a marked tendency for the calyx to split. A plant containing the anther smut fungus is also readily distinguished by a remarkable but characteristic feature of infected flower stalks, viz., marked development of axillary buds. With the exception of a few subsidiary blossom-buds, axillary buds normally remain dormant until the removal of the terminal bud or at most

there is weak development of two or three of the buds in the lower axils. In an infected plant as many as six to eight axillary buds develop before the terminal bud has opened.

The mechanism by which fungal invasion leads to breaking of numerous axillary buds is obscure, but the effect is clearly a favourable one from the point of view of subsequent spread of the disease, for stimulation of development of a profusion of shoots multiplies the number of infected buds. This effect seems analogous with the development, following infection by *Ustilage violacea*, of rudimentary stamens in pistillate flowers of species of lychnis and melandrium, so that these stamens later become infected and smut spores are dispersed on opening of the buds.

Increase in the number of infected shoots also increases the probability that some of these shoots will be taken as cuttings. Plants may be found in which every bud is affected and the disease is obviously systemic throughout the plant. The occurrence of young pot plants which are affected before planting out in the houses is evidence that in some cases contaminated cuttings are responsible for carrying on the disease, for such plants are derived from cuttings struck in clean sand in isolated propagating houses where there have been no blooms that could carry the smut dust. In addition to plants that are probably derived from contaminated cuttings there frequently occur in the beds plants with buds on one side of the plant only affected, and plants with only a single flower stalk affected; in these cases the disease has probably occurred through infection from the smut dust. Conditions in glasshouses appear favourable for infection for the carnation plant has leaf-axils that hold stagnant moisture and is intertwined in beds that tend to retain a moist atmosphere. It is of interest to note that Hecke* obtained 100% infection of moistened buds in the leaf axils of *Melandrium album* by brushing with the fresh smut dust of *Ustilage violacea*.

The elimination of the anther smut fungus from carnation houses appears to be a matter of prevention of infection rather than cure, and such prevention depends on the early recognition of the disease, avoidance of infected plants when taking cuttings, and systematic cutting out of infected shoots and buds so that buds containing the smut dust are not allowed to open. There is a natural tendency on the part of growers, especially those who have not appreciated the nature of the sooty substance disfiguring the blooms, not to bother to cut blooms which are not marketable, whereas they should be cut out and burnt as soon as the buds are seen to be carrying

* Fortschr der Landwintsch 1, 5, 150—1, 1926.

the smut. In order to reduce the extent of infection from the smut dust it seems desirable when cutting to work twice over a bed of infected bloom, on the first occasion cutting normal blooms for market and on the second cutting unmarketable blooms and such buds as may be seen from their shape or the abnormal development of axillary buds to be infected with the smut fungus.

8. Rhubarb Crown Rot and Allied Diseases.

In the Annual Report for 1933 a note was given of a disease of rhubarb, characterized by a dry rot of the vascular system and apparently distinct from Crown Rot, which is a bacterial disease caused by Millard's *B. rhaponticum* (2). Seedlings raised in sterile soil were planted in August, 1933, on a field that had borne a severely-affected crop. Further samples of these plants were examined during the summer of 1936. Whereas some plants had grown to a large size and appeared free from disease others were stunted and abnormal. Those that appeared to be diseased were found to be characterized by two types of lesions:—

(1) Irregular brownish network of vascular bundles.

(2) Extensive coffee-coloured areas of generalized rotting usually considered characteristic of Crown Rot.

In some cases the lesions of the two types graded into each other and appeared to be variations of the same complaint. In others pockets of browned bundles occurred in the centre of the root, and these were often cut off by the formation of a skin. Isolations were made mainly from the necrotic network of vascular bundles for it seemed probable that the pockets were the starting point of the trouble. Fifty-seven isolations were made on rhubarb agar. The results were:—

42 (73%) sterile.
11 (20%) bacterial colonies.
4 (7%) fungi (*Fusarium*) bacterial colonies.

From the very high percentage of results that were sterile it appears that the pockets in many cases contained no organisms. All of six isolations from a crown free from rot, but with numerous black and brown necrotic bundles, gave sterile results and it is reasonably certain that the necrotic network of this crown contained no organisms. Of the fifteen bacterial colonies those obtained from one crown are similar to *B. rhaponticum*, the cause of Crown Rot. Since most of the colonies were mixtures of bacteria it is not possible to say that *B. rhaponticum* was not present in other cases.

Sections, kindly cut by Mr. J. E. Morton from similar material, were found to be characterised by disorganization of the vascular bundles but neither fungi nor bacteria could be traced. The results of examination of the sections confirms that of the isolations in that micro-organisms are not found associated with the necrotic network of bundles. Inoculation of lesions from the pockets of diseased tissue into pot plants raised from seed gave inconclusive results.

The negative results of this investigation, so far, are difficult to interpret on the view that the complex of symptoms usually termed Crown Rot is solely a disease of bacterial origin. They may, however, be compatible with the recent work of Johnson (1), which indicates that eelworm infection is frequently a pre-requisite for the development of Crown Rot.

REFERENCES.

(1) Johnson, L. R (1936). Observations on the occurrence of *Anguillulins dipsaci* (Kuhn, 1853) on Rhubarb in Yorkshire.

(2) Millard, W. A. (1924). Crown Rot of Rhubarb. University of Leeds and the Yorkshire Council for Agricultural Education. Bulletin No. 134.

9. Halo Blight of the Glasshouse Runner Bean

A serious attack of a bacterial disease occurred in the spring of 1936 on a nursery which at that season is mainly devoted to the cultivation of early beans. This disease, variously described as "halo blight," "grease spot," or "stippelstreep," is well known as a widely distributed and serious disease of field beans, but has not hitherto been reported as affecting the English glasshouse-grown runner bean. The disease has been extensively investigated, notably by Burkholder (1) in America, Ogilvie and Mulligan (3) in England, and de Bussy (2) in Holland. The relatively humid conditions in glasshouses appear to be exceptionally favorable to the spread of this disease.

Symptoms.

The disease first appears as a number of reddish pin-points on the leaves, each surrounded by a light-coloured halo. These halos enlarge and tend to become angular as they are enclosed by the venation of the leaf. On the stems reddish streaks appear and at the nodes or bases of petioles water-soaked spots, which enlarge and ultimately result in a wilting of part or the whole of the plant. Milky white drops may ooze from the stems and petioles. On the pods there are water-soaked spots, often bordered with a reddish streak, and sometimes a long water-soaked area extending along the dorsal suture.

An experiment of seed transmission.

Samples of surplus seed from sowing in 1935 and in 1936 were collected from a grower who experienced halo blight severely in 1936 but did not recall the disease in 1935. 39·6% of the 1935 seed and 22·7% of the 1936 seed were found to be marked with irregular discolorations and blisters. The seed was sown singly in pots which on germination were divided into two groups for each year, one group (36 pots consisting of 18 marked and 18 unmarked seed) being kept under bell-jars and the other in a relatively dry atmosphere. Germination for the 1935 seed was 80% (marked seed) and 88% (unmarked seed); for the 1936 seed 88% (marked seed) and 98% (unmarked seed). 4·2% of seedlings from the 1935 seed and 9·7 from the 1936 seed came up stunted and obviously diseased although the bacterial rots developing could not be definitely identified as halo blight. Of the remaining plants all that developed in a dry atmosphere remained healthy and are not considered further. Of the plants under bell-jars 44% shewed on the pair of first leaves a marginal rot bordered by a halo. In 66% of these plants only the diagonally opposite margins of each of the first pair of leaves were affected and this suggested that infection had occurred through the marginal water-pores as the leaves pushed up through the soil. The particles of soil still adhering to the under surfaces of the leaves shewed that it was the margins exposed when the leaves were folded during germination that had become infected, whereas the margins folded within each pair of leaves had remained free. Presumably bacteria present in the coat of the seed had spread into the soil surrounding the seed and re-infected the germinating seedling. The next pair of leaves were clean but on the next pair but one a number of pin-points, surrounded by a halo, appeared in 77% (89% marked; 65% unmarked) of the plants from the 1936 seed and 18% of the plants from the 1935 seed. The experiment was then discontinued owing to attacks of *Botrytis*.

Control.

The experiment described above suggests that differences in degree of seed infection may have been responsible for differences in the prevalence of halo blight in 1935 and 1936, though it is not clear whether the blistering and discoloration present in the seed samples examined were indicative of the extent of the infection. The investigators referred to below all agree that the disease is seed transmitted and it is also probable that, in the absence of a growing crop, the period of survival of the pathogen in the ground is relatively short (3·1931). The experience of nurserymen who favour a seasonal

rotation of runner beans and chrysanthemums tends to confirm this view, for the disease is rarely prominent in the early stages of the crop but becomes progressively worse until finally practically every plant is affected. Moreover, there are occasionally seasons when the disease does not appear at all. These considerations suggest that control of the disease is largely dependant on the provision of clean seed and it seems desirable to bring to the attention of seed merchants this requirement of growers.

REFERENCES.

(1) Burkholder, W. H. (1930). The Bacterial Disease of the Bean, Cornell Agric. Exp Sta., 127.

(2) de Bussy, I. J. le C. (1936). De Bacterieziekte van de Boon, Amsterdam.

(3) Ogilvie, L., and Mulligan, B. O. (1930—33). Progress Reports on Vegetable Diseases II.—V. Long Ashton Exp, Sta. Ann. Repts.

10. Root and Foot Rots of the Glasshouse Runner Bean.

The setting out of runner beans in glasshouses as an early crop is frequently followed by appreciable losses from root and foot rots, especially if the soil is cold and heavy. Some preliminary observations have been made on the nature of the organisms responsible. Owing to soft bacterial decay, following the primary cortical lessons, isolations in standard media proved unsatisfactory and an acid synthetic medium was used which suppressed the growth of bacteria. There appears to be at least four diseases of fungal origin which are due to

(1) *Fusarium mortii*, var. *phaseoli*;
(2) *Thielavia basicola*;
(3) *Botrytis sp.*;
(4) *Phytophthora sp.*

Infection by *Botrytis* has been noted to follow the fall of the decaying cotyledons, which frequently come to rest against the stem and become covered with a furry growth of *Botrytis* that subsequently attacks the base of the stem. Wilt of the entire plant follows. These observations have been confirmed on two nurseries and it seems worth while for growers to remove the cotyledons before they fall so as to eliminate *Botrytis* foot rot. Infection by *Fusarium* and *Thielavia* is presumably largely determined by the environmental conditions, and much further work will be necessary to elucidate the various soil factors concerned.

11. Seed Sterilization.

(a) Tomato seed.

In the Annual Report for 1934 calcium hypochlorite was recommended for the sterilization of lettuce seed. The same

method has now been tested on tomato seed. After sterilization 150 seeds were sown on nutrient agar in separate tubes. 100% germination demonstrated that the treatment did not impair viability and a completely sterile coat was obtained in over 98% of the seeds, for in only two tubes were any micro-organisms detected.

(b) Lettuce seed.

A parcel of seeds was received from a grower who suspected that incipient lesions on seedlings already raised from this batch of seed were early symptoms of an attack of Marssonina. Six boxes were sown (29th October) and an equal number with the same seed sterilized with calcium hypochlorite (120 seeds sown singly per box). Four boxes of each sort were placed in an unheated moist chamber and two of each sort in an unheated frame protected from rain but otherwise exposed. These different humidity conditions did not influence the results, which therefore are not considered separately. Germination was very poor, being 56·3% for the sterilized seed and 53·0% for the unsterilized seed. The number of seedlings shewing brown spots were 5·1% for the sterilized seed and 6·0% for the unsterilized. These differences do not reach the level of statistical significance and it seems probable, from the frequent correspondence of paired lesions on each of the cotyledon leaves, that the trouble (the nature of which could not be confirmed since it did not develop further under the experimental conditions) was too deep-seated to be affected by surface sterilization.

12. A Disease of *Solanum capsicastrum* and Verbena.

E. Oyler.

During July wilted specimens of *Solanum capsicastrum* and Verbena were received. The plants had been standing out in the open, and on the third and fourth days previously severe thunder-storms had been experienced. The aerial parts of the plants were injured and splashed with soil.

The stems of the Verbenas were brown at the nodes, and the leaves arising at these nodes were brown from the petioles upwards. Fungal hyphæ and oospores of the *Phytophthora* type were present in the diseased tissue. Similar symptoms were shewn by the *Solanum* plants. Several branches were also wilting at the tips and zoosporangia were present on the leaves and stems. The roots of all the plants were healthy.

The causal organism was isolated and in each case proved to be a species of *Phytophthora* resembling *P. parasitica.* A wilt of *S. capsicastrum* caused by *P. parasitica* has been described by Orchard in the Report for 1934.

Plants of *S. capsicastrum* were atomised with a suspension of zoospores of the fungus in sterilized water. In some the leaves and stems were slit by means of a sterilized scalpel, in others some leaves were removed and the growing points nipped out, while others were not mutilated in any way. The plants were kept in a moist chamber for twenty-four hours.

The branches cut with a scalpel wilted in an average of eight days and those with the leaves removed, in twelve days. No wilting occurred in the uninjured branches or in the control plants. Tomato plants in size 60 pots collapsed in three days after inoculation with the fungus.

It is concluded that infection occurred when the soil and water was splashed on to plants which had been injured in the storm. The favourable temperature and moisture conditions during the storm would greatly assist infection of the plants.

13. A Disease of the Marguerite.

At the beginning of the year a "black neck" disease of Marguerite was investigated. The leaves of the whole or part of the plant were in a wilted condition and the lower parts of the wilted stems shewed a blackening of the tissues above the soil level. A few of the roots shewed a slight browning. The cortical tissues of the blackened stems were decayed and aseptate fungal hyphæ were present.

The causal organism was easily isolated and proved to be *Phytophthora cryptogea.*

Branches of Marguerites inoculated with the fungus wilted in an average of seven days and later developed the characteristic blackening of the stems. Seedling tomatoes wilted in three days after inoculation with the fungus, which also caused stem rot of wallflower.

14. Virus Diseases.

G. C. Ainsworth.

(a) Tomato.

No new virus disease of tomato was recorded during 1936, but work continued on "bushy stunt" and the disease of the "fern-leaf" type which were described last year.

Bushy stunt appeared to cause no appreciable damage during the past season and was recorded only once; in material from Berkshire examined for Mr. W. Buddin. The symptoms of this disease in tomato, briefly described in last year's Report, pp. 57—58, were the subject of an illustrated article in the Journal of the Ministry of Agriculture (Vol. XLIII. 266—269, 1936)*.

"Enation mosaic" is the name which has been proposed for the disease of the "fern-leaf" type described in last year's Report, pp. 59—60. (The name is derived from the leafy outgrowths or enations which usually develop from the undersides of certain leaflets of infected plants and which appear to be diagnostic for the disease.)

In 1936 enation mosaic reappeared in Lanarkshire and an outbreak was recorded in Sussex, but it was not reported again in the Lea Valley.

Enation mosaic is caused by a virus closely related to that of common tomato mosaic. The symptoms of the disease, under summer conditions, differ from those of common mosaic in being much more severe. The leaves of affected plants become extremely malformed and enations develop. In winter, however, when leaf malformation caused by the common tomato mosaic virus is greater the distortion caused by the enation mosaic virus is much less, so that the two diseases become indistinguishable. This seasonal effect has been examined in a few experiments by subjecting plants to shortened days and so producing winter symptoms in summer. The results of these experiments and a general account of the disease have been prepared for publication.

(b) Lettuce.

Early in 1936 lettuce mosaic was observed for the first time in the glasshouses at this Station. The disease occurred in two plots (both in the same house) planted with the variety Trocadero, grown from one sample of commercial seed. No spread of the disease occurred and no other varieties were affected. Later in the year further material of lettuce mosaic, in both cos and cabbage varieties, was obtained from a commercial nursery and the results of preliminary experiments suggested that only one virus was involved.

(c) Ornamental Plants.

Chrysanthemums are among those perennial plants susceptible to spotted wilt and able to act as reservoirs from which the virus can be introduced into other plants. It is,

* A limited number of reprints of this article are available for distribution. Copies may be obtained by Members, free of charge, on application to the Secretary.

therefore, important to be able to detect the virus in chrysanthemums but, as mentioned in an earlier Report, spotted wilt is transferred with difficulty by ordinary mechanical methods from chrysanthemums to other plants. The results of observations and experiments during the last two seasons have given a partial explanation of the failure to detect the virus of spotted wilt in chrysanthemums, even in plants known to be infected. It was found when healthy chrysanthemum juice was added to a preparation of spotted wilt virus that the virus was completely inactivated. Chrysanthemum juice darkens rapidly on exposure to air and it was thought that possibly oxidising enzymes, or the products of oxidation, inactivated the virus. Other workers have shewn that the virus of spotted wilt is sensitive to oxidising agents and that certain reducing agents, such as sodium sulphite, delayed its inactivation. When chrysanthemum leaves are ground up with a 0·5% solution of anhydrous sodium sulphite instead of water the resulting extract remains green, and if added to a preparation of spotted wilt virus does not at once inactivate the virus. By using 0·5% sodium sulphite solution it has been possible regularly to detect the virus of spotted wilt in infected chrysanthemums by the inoculation of tobacco and tomato plants, when the results of parallel tests with inoculum prepared with water from other portions of the same material were negative*.

Using this method spotted wilt has been detected in several different samples of chrysanthemums received for examination during the year, and the difficulty of diagnosing spotted wilt in chrysanthemums without making inoculation tests has been emphasised. There appear to be considerable differences between the symptoms of spotted wilt shewn by different varieties of chrysanthemum, but to what degree the variation in symptoms is influenced by environmental conditions is at present uncertain. An infected stock of the variety Edwin Seidwitz (developed from a single infected cutting) which has been under observation for several years shews well developed ring and line patterns on the leaves in spring, but later in the season these symptoms are replaced by an indefinite and irregular mottling. A plant of the variety Romance examined when just beginning to flower in the early autumn appeared to be attacked by eelworm, for the lower leaves were dead or dying and those towards the top of the plant shewed yellowing of the veins and various necrotic spots. Careful examination failed to reveal any traces of eelworms, but tobacco plants developed systemic symptoms of spotted wilt after inoculation with a sulphite extract of the plant. In Friendly Rival and another unknown variety yellowing of

* See Nature, CXXXVII., 3473, p. 868, 1936.

the veins of leaves in the upper parts of the plants was a prominent symptom associated with spotted wilt and there was also a little browning between the veins.

It is most important that infected plants should not be used for propagating purposes.

PRIMULA. During the year *Cucumber virus 1* was found causing a serious mosaic disease of *Primula japonica*. The virus of yellow-mottle cucumber mosaic (*Cucumber virus 1*) is becoming very widespread on ornamental plants and has been recorded in this country in china aster (*Callistephus*), calendula, delphinium, lupin, lobelia, viola (pansy), *Primula obconica* and *P. sinensis*, besides in cucumber, tomato, and watercress.

Plants of *Epimedium alpinum* shewing well defined yellow ring patterns on the leaves were examined and although no virus could be transferred to solanaceous plants it appeared probable that the symptoms were caused by a virus.

NARCISSUS. Mosaic or yellow stripe disease was observed in daffodils grown under glass at this Station. Of the different varieties (which were all growing in one house) Golden Spur, the most severely affected, shewed 100% infection, a few plants of Emperor and Spring Glory shewed very mild symptoms, while Madame de Graaf appeared quite healthy. The symptoms in all varieties were of the leaf mottling type; pale yellow and dark green longitudinal stripes.

IRIS. One outbreak of mosaic on bulbous iris (variety Wedgewood) was recorded. About 90% of the plants grown from a consignment of bulbs imported from Holland shewed severe mosaic symptoms and it appeared probable that bulbs were infected before being imported.

LILY. Outdoor grown *Lilium longiflorum* plants shewing a mottling of the leaves similar to that described by Guterman in America, and considered by him to be associated with iron deficiency, were received from Sussex. The cause of this mottling was obscure. It did not appear to be causing any appreciable damage, but some plants were rather severely injured by lily disease (*Botrytis elliptica*).

As usual, several cases of injury to ornamental plants caused by traces of "non-poisonous" (chlorate) weed-killer were recorded.

15. A New Eelworm Disease of the Tomato.

P. H. Williams.

During March, 1936, some young tomato plants were received from Mr. Dudley Howells, of the West of Scotland Agricultural College. They shewed extensive spongy swellings on the stems and leaf petioles. On the stems these galls varied in position, some being at or near soil level while others were 2 or 3 inches above it. They were found to contain large numbers of eelworms which Dr. Goodey kindly identified as *Anguillulina dipsaci*, the stem and bulb eelworm.

Young tomato plants were inoculated by spraying with a suspension of these eelworms, obtained by crushing pieces of gall in sterile water. After twelve days every inoculated plant shewed light green, raised areas on the stems similar to the natural galls. Eelworms were found in these artificially produced galls. Later, narcissi infected with *A. dipsaci* were obtained and tomatoes sprayed with a suspension of eelworms taken from them. Again the inoculations were successful.

The disease has not been recorded previously. Massee (Diseases of Cultivated Plants and Trees, Supplement p. 15, 1915) describes swellings on the roots of tomatoes and attributes them to *Tylenchus devastatrix*, a synonym for *Adipsaci*. He states that the infected plants were decayed above the collar, but does not mention any swelling of the stem prior to the decay which may have been due to other causes. He may have been dealing in reality with the root knot eelworm, *Heterodera marioni*.

The position of the galls suggests that the eelworms were either carried in the water supply or splashed up from the soil. The successful inoculation of tomatoes with eelworms from narcissus points to one possible source of infection. If narcissi infected with the eelworm are used for forcing, the animals may be washed out into the soil of the boxes and from thence into the soil of the house itself. Soil used in forcing should therefore not be used again unless it has been sterilized. Also all bulbs suspected of carrying the eelworm should be treated by heat before being planted.

A short note on this disease was published in the Gardeners' Chronicle, Vol. XCIX., p. 316, 1936.

16. "Water-spot" of Tomato Fruits.

W. H. Read, M.Sc., A.I.C.,
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For many years sporadic outbreaks of a peculiar circular spotting of tomato fruits have occurred on commercial nurseries. The damage occurs from time to time throughout the season but is most serious where plants are growing very strongly and there is an abundance of foliage. The blemish renders the fruit unsightly when ripe and, in consequence, otherwise first quality fruit has to be packed as lower grades with loss to the producer.

This marking is similar in some respects to that caused by aphides when feeding on the fruit, and since all attempts to isolate pathogenic organisms or a virus from affected fruits have failed, the injury has been attributed to the puncturing of the fruit by sucking insects. In one acre of glasshouses on a nursery visited during May, 1936, almost every fruit on plants bearing five trusses each was seriously impaired.

Suggested name for this injury.

It is proposed to call this disfiguration "water-spot," because this is the name which has been applied to the injury by salesmen in Covent Garden Market, probably because the mark bears some resemblance to the deposit left by the drying of a drop of impure water. Further, observant growers have noticed that this spotting is more prevalent when atmospheric conditions lead to the deposition of moisture on the fruit, *i.e.*, "sweating," and the name "water-spot" may have originated from this cause.

The name is appropriate since experimental work has shewn that the presence of small drops of water on the fruit is necessary for the production of these markings.

Appearance of the markings.

The most constant feature of the markings on the fruit is the sharply defined circular appearance of the individual blemishes which are almost invariably formed on the upper half of the fruit, although they may not be noticed until the growth of the truss has exposed the affected areas to easy view. Occasionally the circular appearance is masked by the superimposition of a number of these marks. The spots are apparently formed most easily on immature green fruit but arise occasionally on fully developed fruit which shew slight red colouration.

The most usual type of spot is as follows:—In the green fruit a minute raised speck, dark brown in colour and having the appearance of a particle of dust, is surrounded by a circular zone normal in colour, which in turn is surrounded by a zone of very pale green tissue. The diameters of the spots on fruit taken from nurseries vary from 0·5 mm. to 3 mm. when first observed and rarely exceed 1 cm. on the ripe fruit. When the unaffected portions of the fruit turn red on ripening the outer zone remains yellowish red.

In some cases the inner, normal coloured portion is absent and the central dark brown speck is larger and may be up to 1 mm. in diameter. This type of marking is frequent where the fruit has been inoculated with *Botrytis* spores under atmospheric conditions (described later) which seldom occur on nurseries. A further type of marking has been obtained by inoculation with *Botrytis* spores under certain experimental conditions, but has not been found on commercial nurseries. In this case the central minute dark spot is surrounded by a circle of tissue darker in colour than the remainder of the fruit and which remains dark green after the unaffected portions have turned red.

Experimental production of "water-spot."

Because previous attempts to find a virus responsible for the spotting of the fruit have failed the injury had been attributed to punctures made by insects feeding on the fruit. Careful examination of many of the affected crops failed to disclose a single insect which could be held responsible; furthermore none of the typical indications of aphis injury such as distortion and yellowing of the foliage were present. A number of aphides were obtained from tomato plants and enclosed within a muslin bag covering a truss of immature tomatoes so that their feeding marks could be compared with the spots on the fruit obtained from the commercial nursery. The aphis (*Myzus convolvuli*, Kalt—*M. pseudosolani*, Theob.) caused blister-like marking, whitish green in colour with, in some cases, minute dark centres. The edges of these raised blisters were less clearly defined than the spots previously described, and there were no indications of concentric circles. As the fruit ripened the blister-like area passed through the colour changes later than the normal portions.

It was suggested that the marking might be due to the deposition of some irritant dust on the fruit since the centre resembled a speck of dust and the marks were mainly on the upper side of the fruit. Many likely substances were dusted on the fruit without obtaining similar marks.

During conversation with the grower it transpired that the injury was worse where "sweating" occurred, to such an extent that *Botrytis* rot of the fruit was serious. It seemed likely that the presence of *Botrytis* and the formation of water drops on the fruit were connected in some way with the spots, and a fruit affected with *Botrytis* rot (this fungus being in the spore bearing stage) was selected for the following experiment.

Trusses of immature fruits on several tomato plants were enclosed in wide-necked flasks (boltheads) containing a little water. A number of trusses were sprayed (by means of a scent spray) with a spore suspension obtained from the fungus growing on the rotted fruit, and others with distilled water. The necks of the flasks were loosely plugged with cotton wool.

The flasks were removed after twenty-four hours, and when the drops of moisture had evaporated marks similar to those found on commercial nurseries were seen. This experiment was repeated a number of times and marks were obtained within twelve hours when the temperature averaged 68°F. No marks were obtained on fruit which was sprayed with distilled water.

Further tests were made in a small glasshouse which was thoroughly damped at 8 p.m., and immature tomato fruit on the plants were sprayed with a spore suspension obtained from the fungus on the diseased fruit. The drops of suspension did not evaporate until the ventilators were opened at 7 a.m., and the typical spots were visible within twenty-four hours of spraying the spore suspension over the fruit.

Typical spots were also obtained when *Botrytis* spores were blown on to the fruit previously sprayed with water, but spots were not formed in the absence of beads of moisture on the fruit even though the plants were kept growing in an atmosphere saturated with water vapour for several days. Similar spots were also obtained by spraying immature tomato fruits with a spore suspension prepared from a pure culture of *Botrytis cinerea* isolated from tomato fruits and grown on potato agar in Petri dishes.

It was frequently noticed that the normal "soft rot" of tomato fruits commenced where the immature fruits were bruised when placing the flasks over them. It also occurred occasionally at the blossom end of the fruit if the large drop of water which sometimes collected there did not evaporate within twenty-four hours or so, but the "soft rot" caused in this manner frequently failed to spread through the entire fruit and the affected portions dried up. When the blossom end of the fruit was attacked the final result resembled

"blossom-end" rot. Spots in which the central dark portion was about 1 mm. in diameter were obtained by spraying young fruits with a spore suspension from the pure culture of *Botrytis cinerea*, under such conditions that the drops did not evaporate for thirty-seven hours, and it appears that in this case the progress of the "soft rot" was arrested at an early stage.

In the normal "water-spot" there is no indication of the commencement of soft rot, and examination of sections under a microscope has failed to disclose the presence of fungal hyphæ.

Attempts to reproduce the spots by placing detached immature fruits in bottles containing a little water and spraying them with spore suspensions of *Botrytis* have not been highly successful, since only a few spots have been formed.

The investigation of cases of "water-spot" on commercial nurseries revealed that while *Botrytis* was present in many instances it was absent in others. Where the spotting occurred in the apparent absence of *Botrytis*, tomato leaf mould was invariably present and experiments were therefore made with spore suspensions of the fungus (*Cladosporium fulvum C. ke.*) obtained from tomato leaves.

Trusses of tomato fruits enclosed in flasks as previously described were sprayed with the spore suspension and the flasks removed after twenty-four hours. No markings were discernible after four days after the spore suspension had been applied, but then minute circular marks were seen. In a further five day's time there were many of these typical markings. Control plants, trusses of which were treated in exactly the same manner except that they were sprayed with distilled water instead of the spore suspension, were unaffected. It is of interest that these spots took so long to develop since the marks obtained with *Botrytis cinerea* were seen within twenty-four hours.

Experiments have not been made with a pure culture of *Cladosporium fulvum*, and while it is possible that the markings might be due to the presence of *Botrytis* spores in the spore suspension obtained from the tomato leaf affected with leaf mould the time taken for the marks to develop indicates otherwise. Furthermore, no *Botrytis* was seen on the leaf from which the *Cladosporium* spores were obtained.

Discussion.

It has been found that the ring-like spots are formed only when spores are suspended on the fruit in minute drops of moisture similar to those formed by natural condensation during "sweating."

When the *Botrytis* spores are suspended in large drops a slightly raised or blister-like spot is formed where the drop was in contact with the fruit. This spot, when formed on immature fruit, is lighter in colour than the rest of the surface and does not pass through the colour changes as quickly when the fruit ripens.

The actual manner in which the ring-like spots are formed is obscure, but it is possible that they are due to the liberation of some toxic substance when the spores of *Botrytis* germinate in the drops of moisture but fail to develop further before the drops dry up. Microscopical examination of sections of the spots has shewn that the dark central speck consists of dead cells.

Control measures.

Considerable condensation of moisture frequently occurs at night in unheated glasshouses, especially where abundant foliage prevents the free circulation of air around the plants. The wounds made when trimming the plants often become infected with *Botrytis* under such conditions and the lesions are centres of luxuriant spore production. Humid conditions and temperatures exceeding 70°F. are conductive to attacks of *Cladosporium* also, which grows rapidly and produces innumerable spores. The "sweating" of tomato plants indicates, therefore, that drops of water on the fruit and fungus spores are likely to occur together and produce "water-spot."

Control measures must commence with the prevention of conditions favourable alike to the condensation of moisture on the plants and growth of *Botrytis* and *Cladosporium*. Care must be taken to see that the atmosphere is as dry as possible before ventilation is reduced at night. Where strict attention to ventilation is insufficient to prevent "sweating," as much foliage as possible should be removed and, if necessary, heating of the houses restarted. The plants should be damped overhead only when atmospheric conditions permit their drying within a few hours, since "water-spot" might result from the continued presence on the fruit of drops of water due to injudicious damping. While "over-head damping" assists the fruit to set, it should be done in the morning, except during very dry hot weather.

Where the plants are infected with *Botrytis* the usual methods for controlling this disease, such as trimming out the affected portions of the plants and painting the wounds with a paste of liver of sulphur, must be enforced. Methods for the control of tomato leaf mould have been published by the Cheshunt Research Station.

In a recent paper by Dr. Walton, of the Long Ashton Research Station [The cause of a "spotting" of tomato fruits (*Stigmonose*) Gard. Chron., Vol. CI., No. 2610, pp. 12—14, 2nd January, 1937] it is claimed that "Stigmonose" or "halo-spot" is produced by the action of sunlight upon water droplets on the fruits. In our experiments no marks were produced on fruit sprayed with distilled water but otherwise treated in the same manner as fruit which was sprayed with suspensions of spores of the fungus *Botrytis* and on which typical spots developed. We prefer to retain the name "Stigmonose" for the markings caused by aphides feeding on young tomato fruits. Experiments with the aphis *Myzus convolvuli*, Kalt, previously described, and observations in commercial nurseries and at the Research Station nursery have proved that aphides do cause a marking of tomato fruits. *Myzus convolvuli* was found on tomato plants on several nurseries this year and we are indebted to Mr. F. Laing, of the British Museum, for its identification.

3. Animal Pests.

1. A Leaf-miner of the Tomato Plant.

E. R. Speyer.

During the growing seasons of 1935 and 1936, the leaf-mining larvæ of the fly, *Liriomyza solani*, Macq., has caused some injury to the foliage of tomato plants upon a nursery at Edmonton, Middlesex. The first, and apparently the only previous record of this insect in British glasshouses dates from July, 1926, when it appeared in the same district but upon a different nursery. A few leaves mined by the larvæ were collected from the experimental houses at Cheshunt in August, 1935.

The mines were in evidence in tomato houses as early as May, when large numbers of adult flies were also present. Successive generations led to a maximum infestation, usually of the older leaves, in July and August.

In general habit, the insect resembles very closely the chrysanthemum leaf-miner. The pupal stage is passed at the extremity of the mine, but shaking of the branches very easily causes the pupæ to fall to the ground.

The mines, which tend to heal up after larval feeding has ceased, much resemble those of the leaf-miner found upon sow-thistle (*Sonchus*), but the latter insect, which appears to be identical with the chrysanthemum leaf-miner (*Phytomyza atricornis*, Mg.) is, as the adult fly, much larger and much less brightly coloured.

Many Braconid parasites were bred from the mines of *Liriomyza*, but these were obtained only in late summer, and did not effect any marked degree of control.

Although at present of very local distribution, this pest was very serious in the nursery upon which it occurred.

As a remedy, spraying with nicotine and oil emulsion was resorted to, and though dead larvæ were found in the mines, the pupæ were not killed, and it is not as yet certain whether the method of control is effective. Nicotine fumigation has also been tried with promising results.

In Spain, the use of a poison-bait spray, consisting of 0·25% sodium fluosilcate and 2% brown sugar, has been recommended for the control of a closely allied fly which is injurious to the chick-pea (Cicer).

2. "Thrips" injurious to the Carnation Plant

E. R. Speyer.

Investigations into methods of control for the Onion Thrips (*T. tabaci*, Lind.) have been continued. Fumigation with the vapor of naphthalene may prove to be a good means of destroying the insects, when they are concealed amongst the petals of carnation flowers. For the purpose, a naphthalene lamp was employed, with the temperature of the glasshouse between 52°F. and 60°F., during the period of fumigation, which was carried out during the night. When 6 ounces naphthalene were volatilised in a house of 1,000 cubic feet capacity, over a period of about twelve hours, all larvæ and the majority of adult insects, amongst the petals of partially opened and fully open blooms, were killed. The house was fumigated twice, subsequently at intervals of one week, and complete control of the pest appears to have been effected.

These experiments were carried out in September and early October: control of Thrips was also obtained in May in a house of 3,000 cubic feet capacity without injury to the plants.

Owing to their susceptibility to damage from the vapor of naphthalene, even in very small quantity, it is not considered advisable to fumigate carnation plants during the winter months.

3. Mushroom Pests.

During the summer, the new mushroom shed at the Experimental Station was severely infested with Sciarid and Phorid flies. Presence of the former insects upon the shelves was detected in April, and their numbers increased during May to such an extent that the flies were swarming in the early part of June.

Phorids (of the genus *Megaselia*), on the other hand, made their appearance more or less suddenly, and in vast numbers at the beginning of June.

On 10th June both these flies were swarming upon the windows of the packing annexe, and from a collection made at random it was found that all the Sciarids were of the female sex, and that in the case of Phorids females were nearly thrice as numerous as males.

A collection made upon the same day from the surface of the shelves shewed the sexes of the Sciarids to be practically equal in proportion, while male Phorids were nearly twice as numerous as females.

On this date the shed of 6,000 and the annexe of 1,000 cubic feet capacity were fumigated with ¾ lb. nicotine shreds to the former, and ¼ lb. to the latter.

The number of flies killed was small, and a second fumigation, using 2 lbs. shreds to the shed, and ½ lb. to the annexe was carried out. From sheets of paper placed in different positions upon the tiers of shelves, a collection of dead and paralysed flies was made on the following day: 135 Sciarids (68 males and 67 females) and 169 Phorids (81 males and 88 females) were obtained, but a number, especially of the former flies, recovered subsequently.

Though fumigation with nicotine shreds may be valuable as a means of control when but few flies are present, it appears doubtful as to whether such fumigation is economically practicable when infestations have become severe.

Such examination of the compost and casing soil as could be made, revealed the presence of large numbers of Phorid pupæ in the former, but very few in the latter. No larvæ could be detected in either, though those of other flies were found, and no eggs appeared to be present in the casing soil. Eggs and young larvæ were present at the bases of mushroom stalks, and older larvæ which had tunnelled up the stalks occurred in large numbers in the caps. Sciarid larvæ destroyed the pin-heads.

A number of insects and mites collected from mushroom beds in various parts of the country were received. These included a few adults and a large number of the red larvæ of the Mycetophilid fly, *Pezomyia vanderwulpi*, Meij.

Mites of the genus Tyroglyphus were twice recorded, and on each occasion these were very kindly identified by Mr. S. G. Jary as *T. longior*, Gerv. The second record from Worthing, in October, relates to typical mite injury, where large holes had been eaten in the caps. This establishes the fact that this species of mite causes serious injury to the mushroom crop.

4. The Control of Red Spider Mite on Carnations.

W. H. Read.

The control of red spider mite on carnations still presents many difficulties, especially where the infestation is severe on soft growth early in the year. Experiments conducted in January and February shewed that under such conditions fumigation with naphthalene is likely to cause severe injury

if sufficient vapour is present to destroy the mites. In addition heavy condensation of naphthalene on the glass due to low external temperatures may reduce the concentration of vapour in the house below the minimum required to kill the mite.

The possibility of using an emulsified synthetic wax solution for controlling red spider mite on carnations has been investigated. Preliminary tests were made early in May, when it was found that active stages of the mite were destroyed by spraying with the emulsion at a dilution of 1 in 100, but some eggs and resting stages survived. The carnation plants sprayed were pot plants which had been drastically cut back some time previously and consequently possessed much soft young growth. This soft growth was injured by the spray where drops collected, but older leaves were uninjured and the bloom on the leaves was only slightly discoloured. Tomatoes, cucumbers, and roses were all very seriously injured by spraying with the wax emulsion of 1 in 200.

The spray did not wet the carnation leaves effectively at 1 in 100 and a second series of tests were made in which wetting agents were added to the spray fluid. It was found that the addition of 0·1% of Agral 2, a proprietary synthetic wetter, allowed the concentration of the emulsion to be reduced to 1 in 140 without loss of efficiency when compared with the 1 in 100 dilution containing no added wetting agent. The injury to soft young growth and marking of the foliage appeared slightly less where the wetting agent was employed.

These preliminary tests having proved satisfactory, spray trials were made at intervals throughout the year. Good control of red spider mite was obtained by spraying with the emulsion at 1 in 100 without a wetting agent or at 1 in 140 with 0·1% Agral 2, provided a second spraying followed about a week or ten days after the first. Unfortunately both these sprays caused slight injury to the flowers at all times and frequently damaged the young foliage when applied during hot bright periods. The wax emulsion cannot be regarded, therefore, as satisfactory for the control of red spider mite on carnations in its present form, and further experience in its use throughout the present season is necessary before any recommendations can be made.

Several emulsions containing naphthalene have been tried against red spider mite on carnations, but it has not been possible to prepare any from which naphthalene does not separate out on dilution, except by the use of solvents which injure the plants.

5. Rose Thrips *(Thrips fuscipennis*, Hal.)

O. B. Orchard and W. H. Read.

At the beginning of May a serious outbreak of this insect occurred in the rose house at the Experimental Station. Before any attempt at controlling the outbreak was undertaken all blooms ready for cutting were collected daily from the plants between May 5th and 8th inclusive, and each was examined by the entomologist for signs of injury and the presence of insects amongst the petals of each of the four varieties grown.

Blooms of the variety Roselandia were most susceptible, the injury frequently amounting to malformation, but while those of the variety Richmond were susceptible, general malformation was rare.

Amongst the petals of these two varieties insects in all stages of development were found. Blooms of the variety Talisman frequently contained adult insects, but young stages were extremely rare, and injury to petals when present was very slight.

The results obtained from the census taken are given in the first portion of the accompanying Table.

On May the 8th all plants in the house were sprayed with a proprietary nicotine-in-oil insecticide* which had previously proved effective in killing thrips on other crops.

The preparation was used at a strength of 1 fluid ounce in 1½ gallons water, with subsequent applications at weekly intervals until the end of August.

After the first spraying dead adult thrips were found upon the foliage of the plants, and amongst the petals of the flowers, where the larvæ were occasionally killed, though the pupal stages were not affected by the spray.

During the period May 11th to June 11th, a similar census of the blooms was undertaken by the entomologist, the results of which are shewn in the second potrion of the Table.

At the end of August it was almost impossible to find any trace of thrips or thrips' damage on the foliage or blooms, and although the evidence is not conclusive, it is highly probable that the insecticide employed had effectively controlled the pest. Experiments will be continued throughout the coming season.

* Nicotrol.

May 5th—8th, 1936.

Variety.	Blooms Injured.		Blooms Uninjured.		Total Injured.	Un-injured.	% Injured.	% A.
	A	B	A	B				
Roselandia ...	31	10	13	40	41	53	44	47
Sylvia... ...	1	1	1	3	2	4	33	33
Richmond ...	6	2	0	14	8	14	36	27
Talisman ...	4	1	8	16	5	24	17	41
	42	14	22	73	56	95	37	42

A. Blooms containing insects.
B. Blooms not containing insects.

May 11th—June 11th, 1936.

Variety.	Blooms Injured.		Blooms Uninjured.		Total Injured.	Un-injured.	% Injured.	% A.
	A	B	A	B				
Roselandia ...	11	15	4	46	26	50	34	20
Sylvia... ...	1	4	2	24	5	26	16	10
Richmond ...	0	5	2	16	5	18	22	9
Talisman ...	1	2	16	49	3	65	4	25
	13	26	24	135	39	159	20	19

A. Blooms containing insects.
B. Blooms not containing insects.

Experiments on commercial nurseries.

Early in May reports were received of an almost complete loss of the first crop of flowers on a large rose nursery, and in view of the extensive nature of the damage the following experiments were undertaken.

Immediately after pruning the first crop the bushes were sprayed with the nicotine-petroleum oil emulsion which had previously been tested in the rose house at the Experimental Station.

The first three sprayings were applied at weekly intervals, using a hand sprayer. Dead adult thrips were readily found on the foliage, but the general infestation did not appear to be decreasing. It was therefore decided to use approximately

one third the quantity of fluid normally applied at each application, using a very high pressure, and to spray on alternate days. The object of this was to wet only the young foliage, and the daily sprayings were continued until the flower buds developed. The damage caused to the blooms by the insect was considerably less than that to the previous crop.

After pruning the bushes for the next crop, heavy applications of the nicotine-oil spray were again applied. Very few insects were found on this crop, and no further control measures were employed.

In previous years it has been observed that thrips seldom cause serious damage at the latter end of the season, therefore it is not possible to ascertain fully the value of the control measures employed.

In another series of experiments hydrogen cyanide fumigation generated from cyanogas has been employed.

Fumigations have been conducted immediately after pruning in the autumn for the final crop of the year, using ⅔ ounce per 1,000 cubic feet. After fumigation, large numbers of dead adult thrips have been found on weeds growing beneath the bushes. Later, the blooms were practically free of the pest, but it is too early to form a definite opinion of the value of the fumigations.

These trials are being continued throughout the coming season where previous crops have been heavily infested with the pest.

A number of insecticides and baits have been tried for the control of thrips on roses, but none has proved satisfactory.

6. Millepede Control (*Blanjulus guttulatus*, Bosc., and *Orthomorpha gracilis*, Roch.).

O. B. Orchard.

During the past season, observations on a number of nurseries shew that damage to cucumber crops caused by millepedes has been unusually severe. Several cases have been observed where as many as 50% of the plants set out in August for the second crop have collapsed shortly after planting out as the result of the insects devouring the roots beneath the soil. Under such conditions the insects are usually present in large numbers around the roots of the plants, and may be found throughout the bed.

The use of naphthalene, and the light spraying with nicotine previously recommended, as control measures destroys those at the surface only, and therefore is too slow in action under such conditions as those described above. For this reason, the following trials have been conducted in cucumber houses where a second crop of plants just commencing to fruit had already collapsed.

Late in the afternoon the beds and borders were soaked with nicotine 1 part by volume in 2,000 parts of water with the addition of a wetting agent of the sulphonated oil type (in these experiments agral N. was used at a strength of 1 fluid ounce in 8 gallons water). The solution was applied at the rate of 1 gallon to 6 feet run of border.

The following morning the beds, borders, and paths were very thickly covered with millepedes. Examination shewed that approximately 80% of these were dead, but during the day the remaining 20% recovered and crawled back into the beds. In later experiments, the morning after drenching the beds, the exposed insects were lightly sprayed with nicotine at the strength used for drenching, applying approximately 1 gallon in a house 100 feet long by 14 feet wide. This method was effective in killing all the insects driven from the beds. It is probable that lower concentrations than those employed would be effective in driving the insects from the beds, control being effected by spraying the exposed insects, but it has not been possible to conduct experiments with weaker concentrations.

The experiments described above have been repeated in several nurseries, and in each case one drenching proved sufficient to exterminate even heavy infestations.

This method of control is comparatively expensive, but is suggested as worthy of trial by those growers who are faced with a sudden and heavy outbreak of the pest on young growing plants.

When attacks are only slight the methods suggested in the last Annual Report are recommended.

A limited number of experiments have been made with naphthalene dust, and very promising results have been obtained. Owing to the fine nature of the dust, it is possible to shake it deeper into the beds during application than flake naphthalene, and by dusting a small quantity over the beds once a fortnight the pest is apparently kept in check.

Control was more effective when the beds were watered immediately after applying the dust. This is probably due to the dust being carried deeper into the beds.

7. General Work on Fungicides and Insecticides.

W. H. Read.

Many samples of insecticides and fungicides submitted for examination have been tested against the insect pests and fungus diseases of glasshouse pests. The majority of the insecticides were derris preparations. The fungicides included several so-called "colloidal-copper" mixtures, the composition of which have not yet been ascertained. The efficiency of these in controlling tomato leaf mould and cucumber mildew was increased by using them in combination with petroleum oil emulsions.

Additional tests have been made with several substances which yielded inconclusive results in last year's experiments in the control of *Phytophthora cryptogea*, the fungus mainly responsible for "damping off" of seedlings. None of these substances were effective in preventing the fungus from attacking tomato seedlings when used in amounts which had no injurious effect on the germination and subsequent growth of tomato seedlings. Acetic acid and hydrogen peroxide were tried as substitutes for formaldehyde for the partial sterilization of propagating soil. Hydrogen peroxide was decomposed with great rapidity in contact with soil and unless very dilute solutions were used it was impossible to wet the soil on account of the frothing due to the evolution of oxygen. *Phytophthora cryptogea* was not destroyed by the application of 0·75% solutions to infected propagating soil. Acetic acid at a dilution of 1% failed to control the fungus in the soil.

4. Chemical Investigations.

O. Owen.

1. General.

During the past year the number of samples of various kinds submitted for examination was more than twice that submitted five years ago. The majority of samples were of soil but the range of samples generally is extending. Nothing of outstanding interest or importance in the soil analyses can be reported, practically all being analyses for the purpose of ascertaining manurial requirements.

It is gratifying to note that growers are shewing an increasing tendency to have possible water supplies examined before committing themselves to expenditure on wells and pumping plant and, on occasion, before starting nurseries. This is always advisable because considerable expense and trouble can be avoided by adopting this course.

In some districts salt in soil and in water supplies continues to be a source of constant trouble.

One case of a water containing iron in excess came to our notice. Treatment of the water with gypsum rock had been tried. Analyses shewed that whereas this treatment only reduced the iron content to half its original value the resulting water was four times as hard and the total solids were almost trebled.

2. Chlorate Weed-killers.

Once again it is necessary to call the attention of growers to the care which must be exercised in the use of these compounds. During the year under review cases of damage to all the commoner crops handled in nursery work have been met with, and the range of plants shewing high susceptibility to chlorate injury is extremely wide. It must be remembered, too, that pots are very retentive of chlorates. This raises a point of considerable importance. Often chlorates are used either on plants which are not particularly susceptible or on the ground on which the pots stand. If these same pots are used again later for other plants there is serious risk of chlorate remaining in the earthenware and causing serious injury to plants of ordinary susceptibility. These pots, too, will generally carry sufficient chlorate to contaminate soil in houses and a following crop of susceptible plants such as tomatoes will suffer damage.

3. Mushroom Compost.

Preliminary experiments have been carried out on the gases evolved in a manure heap during preparation for mushrooms. The number of analyses is insufficient to justify any definite conclusions, but the indications are as follows:—Each turning of the heap and the resulting exposure to air increases considerably the carbon dioxide evolved. Within quite a short time the carbon dioxide concentration falls considerably—often to a half or less of the "peak" value shewn the day after turning. The lower values appear to persist until the next turning, which is again followed by a peak value.

Evolution of gaseous ammonia appears to follow the same changes with one difference. Following the turning ammonia is evolved, but evolution appears to cease completely after four or five days, whereas the evolution of carbon dioxide continues.

Another point of interest is that the ammonia appears to be generated at the surface only, and not inside the body of the heap. During one turning a wide glass tube was fixed vertically in the heap with the open end about 2 feet below the surface. The other end was stoppered and fitted with a bent tube through which a sample could be taken. The day after turning traces of ammonia were detected in the tube but none on subsequent days, although ammonia was detected at the surface of the heap during five days after the turning. Another experiment confirmed these findings. A wire basket about a foot cube was buried—during the turning—about 2 feet below the surface and connected with the air by a wide tube. Again traces of ammonia were detected in the tube the day following the turning, but none subsequently.

When the manure was made into beds in the shed the carbon dioxide production was considerable for the first two days but fell considerably afterwards. Ammonia was produced but only until the seventh day, after which none was detected.

A number of analyses were made of the air immediately over the three beds in the shed. It was found that, generally, the concentration of carbon dioxide over the bottom bed was highest. Sometimes the concentration at the middle bed was higher than that at the top bed. It was thought at one stage that this variation might be due to disturbance by the workers, etc., but similar results were obtained when sampling was carried out after the shed had been closed for some time.

The following are typical of the results obtained :—

Percentage of carbon dioxide.				
Over bottom bed.		Over middle bed.		Over top bed
0·514	...	0·180	...	0·192
0·396	...	0·304	...	0·342
0·300	...	0·207	...	0·254
0·546	...	0·311	...	0·224

5. Physiological Investigations.

1. A further investigation of the movement of assimilate in tomato seedlings.

B. D. Bolas and D. W. Goodall.

In last year's Report, evidence was given for the view that a considerable amount of the assimilate produced in the leaves of seedling tomatoes, variety E.S.1, passed out of the leaf during the day and that translocation was not to be regarded as a process confined to the dark period.

In those experiments the plant was divided into three parts: stem, root, and leaves, the leaf system being considered as a whole and no study made of the behaviour of individual leaves.

During the summer of 1935, a new type of experiment was undertaken in which the changes taking place in individual leaves were investigated, and these suggested a very marked flow of assimilate from the leaves which are most active in photosynthesis to the small leaves which are carrying out less photosynthesis but are increasing in size very rapidly. The results of one such experiment are shewn in Figs. 1 and 2. Fig. 1 shews the percentage change in dry weight of each part of the seedling during a period of six hours' illumination, and Fig. 2 shews the changes during a seventeen-hour dark period. It will be seen that all the leaves gained in dry weight during the light, but that during the dark the more mature leaves lost weight, while the younger leaves gained. This suggested that there was a transference of material from the older leaves to the younger during the dark, but it gave no quantitative data concerning translocation as the correction to be made for losses by respiration was unknown.

After this experiment the methods of work were greatly improved, enabling determinations to be made of the respiration, assimilation, and translocation in each leaf individually, and in the stem and the root. The methods will be described fully in another publication, but may be summarised very briefly by the statement that the changes in dry weight of leaves growing on normal plants are compared with the dry weight changes of leaves exposed to the same environmental conditions but detached from the plants and kept with their petioles in water. From eight to ten replicates were used in each experiment, enabling the variance and error to be determined. The methods have been tested and found highly satisfactory for the low assimilation rates occurring in winter

Figure 1.

Percentage change in dry weight after six hours' illumination.

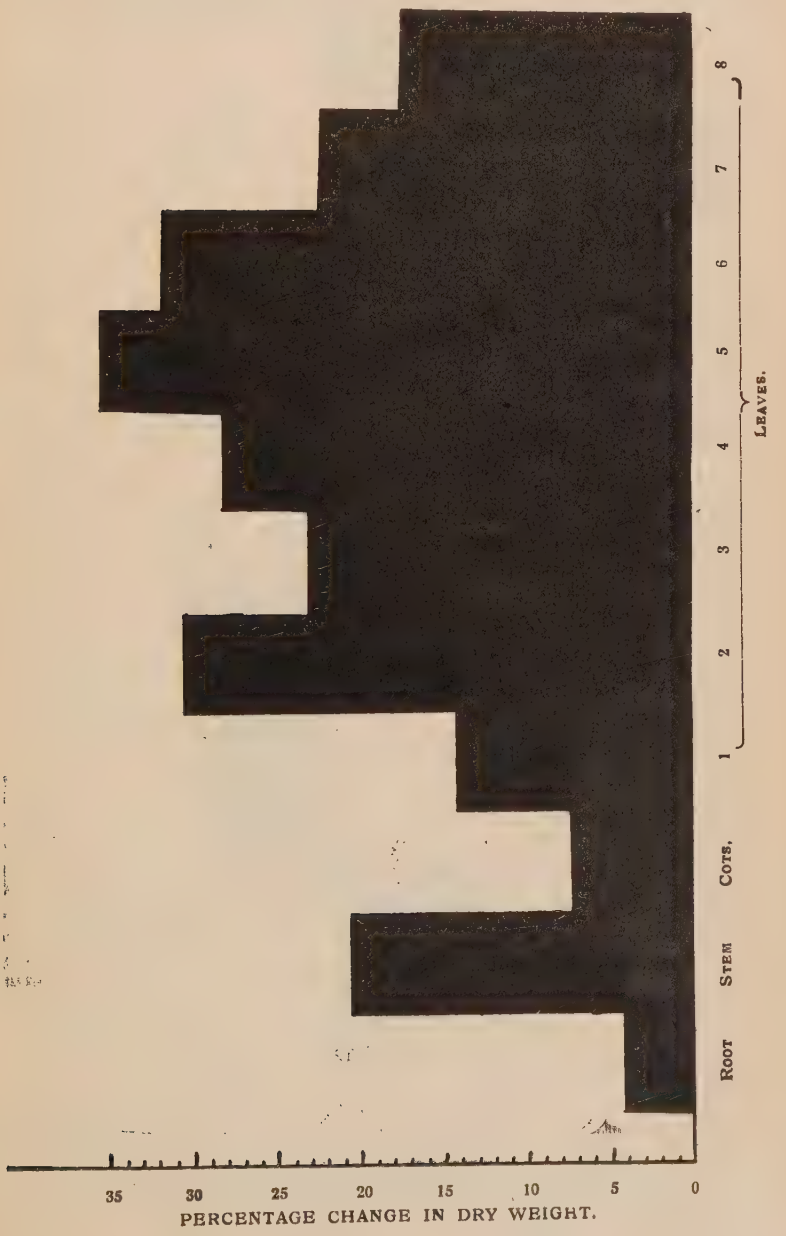
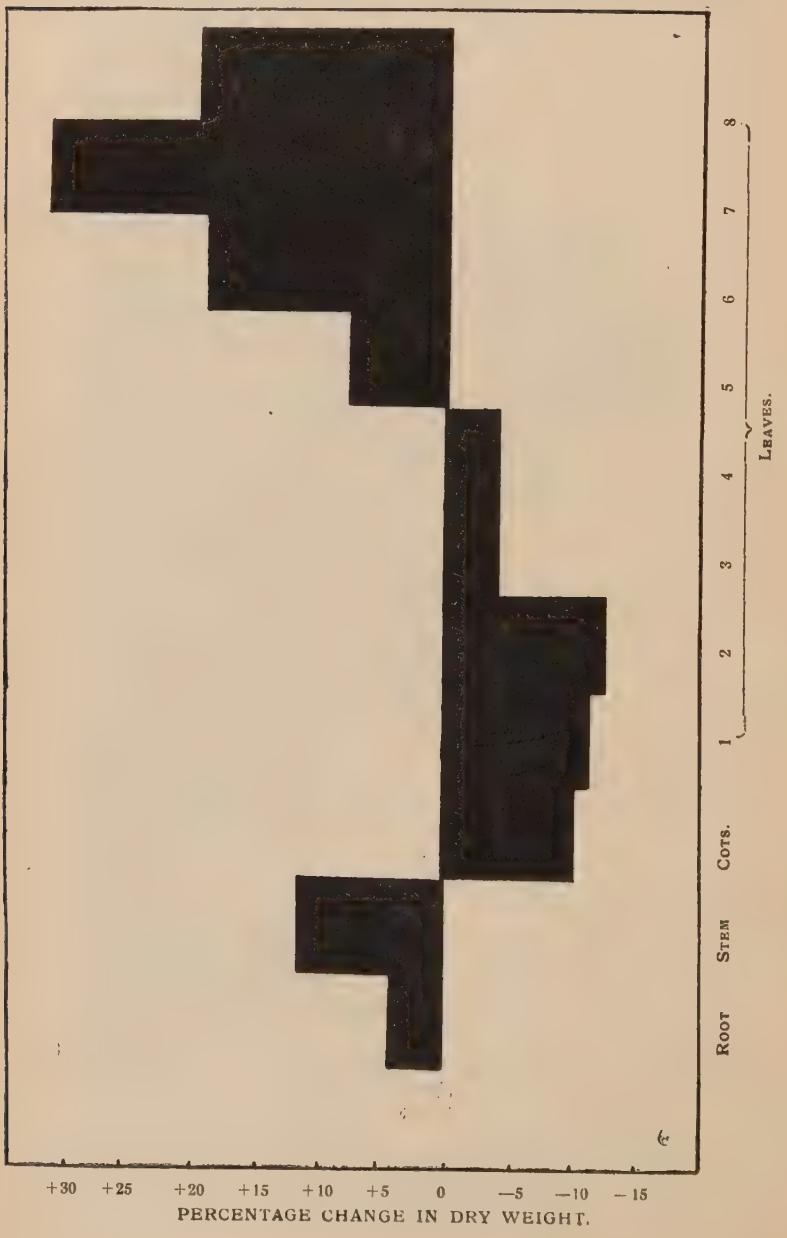


Figure 2.

Percentage change in dry weight after seventeen hours' darkness.



but have not yet been tested under summer conditions. In the experiment described below the following changes in dry weight were found for the plant as a whole (8 replicates):—

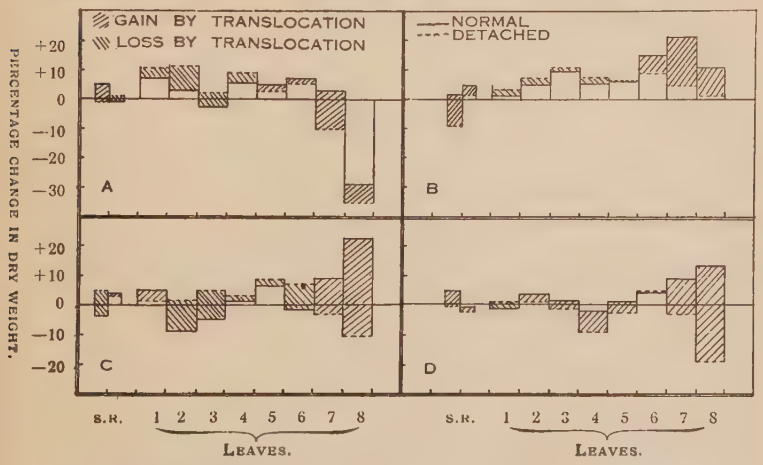
Period.	Leaves and stem in water. Root in moist paper.	Leaves on plant.
Dawn to midday ...	+4·2±1·3	+2·9±1·05
Midday to dark ...	+3·4±1·4	+5·3±1·30
Dark to Midnight ...	+4·0±1·4	—0·3±1·20
Midnight to dawn ...	—1·6±0·9	+1·7±1·10
Total change ...	+10·0±2·3	+9·6±2·30

From this it is clear that the changes in the whole plant do not differ significantly from the sum of the changes in the separated plant parts.

The results of an experiment carried out on 11th January, 1937, are shewn by four graphs in Fig. 3. Each graph shews the percentage change in dry weight of each part of the plant during the period marked on the graph; the values obtained for the leaves growing under normal conditions are shewn by the continuous lines, while the dotted lines represent the values obtained for the leaves detached from the plant, this preventing any flow of assimilate into or out of the leaf.

Figure 3.

Translocation in an eight-leaf tomato seedling, 11th January, 1937.



If one makes the assumption that assimilation and respiration proceed at equal rates in the attached and detached leaves, then any difference in the change shewn by two similar leaves, one attached to the plant and one detached, must be

due to the flow of assimilate to or from the attached leaf, except for such differences as may be due to changes in mineral matter content. In the diagrams the movement of assimilate is represented by shading, different shading being used to indicate movement of assimilate into and out of the leaf. In considering these graphs it should be remembered that the change in each organ is shewn as a percentage of the initial dry weight of that organ; the dry weights of the different parts form widely differing proportions of the total dry weight of the plant, and therefore a large percentage change in the dry weight of the eighth leaf will only correspond to an almost imperceptible percentage change in the dry weight of the whole plant. Table 1 shews each part as a percentage of the total dry weight of the plant at the time of this experiment, and the mean probable error of the changes expressed as a percentage of the dry weight.

Table 1.

Part.	Dry weight of part expressed as % of dry weight of whole plant.	Mean probable error.
Leaf 1	8·82	1·81
„ 2	12·73	2·69
„ 3	13·38	2·24
„ 4	13·01	2·67
„ 5	8·75	2·60
„ 6	4·84	3·60
„ 7	1·59	4·15
„ 8	0·33	7·41
Stem	20·04	3·45
Root	16·51	4·20
Whole Plant ...	100·00	1·20

Graph A., Fig. 3, shews the percentage changes in weight of the parts during the period, dawn (7.30 a.m.) to midday, graph B. the changes during the period midday to dark (4.50 p.m.), graph C. dark to midnight, and graph D. midnight to dawn.

An examination of Fig. 3 suggests the following conclusions:—

1. The respiration rate of the youngest leaves is exceedingly high.

2. There is a flow of assimilate from the more mature leaves to the younger leaves during the whole of the twenty-four hours and very little of the gain in dry weight in the youngest leaves is due to their own assimilation.

3. That this flow of assimilate may reach its maximum during the afternoon and evening, this possibly being related to the accumulation of assimilate in the older leaves during the course of the day.

2. Some preliminary observations on the position of the inflorescence in the tomato plant.

D. W. Goodall.

The position of the first inflorescence or flower truss varies considerably in the tomato plant. Usually it is formed at the tenth or eleventh internode (that between the cotyledons and the first foliage leaf counting as the first), but it may be as low as the seventh or as high as the fifteenth. Even in plants of the same batch as many as six different positions have been observed.

In considering the causes of this variability, differences in the morphology and physiology of individual plants were first examined. Accordingly, a number of E.S.1 seedlings at the twelve-leaf stage grown from three different batches of seed were measured, and the relation between the position of the first truss and the length of the fifth leaf and of the stem (from cotyledons to apical bud) was determined. The results are given in Table 1 in the form of a correlation coefficient, "r"; a perfect relationship is expressed by a value of 1·000 or —1·000, while a value of zero indicates that there is no relationship. The probability of the value of "r" being obtained by random errors, without signifying any real relation between the measurements, is given under "p"; a "p" value of ·05 represents a chance of one in twenty.

Table 1.

	No. of plants.	Correlation with stem length.		Correlation with length of fifth leaf.	
		"r."	"p."	"r."	"p."
(i)	28	—·316	·1	—·417	·03
(ii)	21	—·506	·02	—·541	·01
(iii)	43	—·514	<·01	—·415	<·01

These coefficients indicate that the larger plants will tend to form the first truss at an earlier stage of development than the smaller ones. This is found to be due to a difference in growth rate rather than in time of germination.

The next morphological feature related to the position of the first truss is the insertion of the first pair of foliage leaves. Most batches of tomato plants can be divided into two groups. In one, the first two leaves are opposite one another, while in the other they are alternate. In some plants, though these leaves are not precisely opposite they do not fall into the spiral formed by the younger leaves; in their physiology, these plants appear to belong to the group in which the two lowest leaves are opposite.

If the position of the first truss is noted in a number of plants belonging to each of these groups, it will be found that plants with the lowest leaves opposite one another form the truss substantially later in their development than those in which the first two leaves are alternate (see Table 2).

Table 2.

Variety.	Mean position of first truss in plants with lowest leaves alternate.	Mean position of first truss in plants with lowest leaves opposite.
Ailsa Craig... ...	11·17	11·46
Bides Recruit ...	11·17	11·96
Duvaux Radio ...	9·67	10·19
E.S.1	10·67	10·80
Kondine Red ...	9·35	10·33
Potentate	10·32	11·00
	"t"—4.13	"p"<.01

This difference is not due to a difference in leaf area between the two groups, for the opposite-leaved plants have rather larger leaves than those in the other group.

The relationship shewn in Table 1 seems to indicate that the formation of a truss may not take place until a certain area of assimilating surface is present. To investigate this matter further, experiments were carried out to find the effect on the truss position of reducing the assimilating surface. The first two experiments, in which leaves were removed some days after the plants had been potted up, gave no conclusive results, but a third was more successful. Two boxes were sown on 10th October, 1936, with E.S.1 seed, and in half of the seedlings in each box the cotyledons were cut off with scissors as soon as they began to separate from one another and expose the plumule. In all the seedlings in one of the boxes, the first pair of foliage leaves were also removed before they reached a length of 1 cm. These plants were all grown until the first truss could be seen, and its position was noted. The results are given in Table 3.

Table 3.

Treatment.	No. of plants.	Mean position of first truss.	Probable error of mean.
Normal plants	15	10·20	·10
First pair of leaves removed	11	10·55	·19
Cotyledons removed ...	10	11·00	·14
Cotyledons and the first pair of leaves removed ...	10	13·10	·19

It will be seen that both removal of the cotyledons and of the first foliage leaves tend to cause the truss to be formed at a higher internode, but that the effect of removing the cotyledons is greater. It is probable that the earlier experiments were unsuccessful because the organs were removed at too late a stage to affect the position of the truss.

A further question to be investigated was whether the truss position was affected by innate factors, apart from any that might govern plant size and the position of the first pair of leaves. From observations on crop plants of a number of varieties (see Table 2), it was evident that the latter was not the sole factor, but unfortunately no data from this source were available in respect of plant size. Accordingly, seed freshly gathered from four E.S.1 plants differing widely in respect of both size and truss position was grown, together with mixed E.S.1 seed two years old that was being used for propagation in the Virus House. The remarkable result was obtained that, while the four batches grown from newly-gathered seed did not differ notably in mean truss position (for the greatest difference, $p = \cdot 05$), they all differed significantly from the batch grown from old seed (see Table 4).

Table 4.

Date of Seed.	First truss of parent.	Mean position of of first truss in offspring.	No. of plants.	Probable error of mean.
1934 ...	Various ...	10·88 ...	41 ...	·10
1936 ...	9 ...	9·77 ...	30 ...	·17
1936 ...	10 ...	10·16 ...	23 ...	·09
1936 ...	11 ...	9·71 ...	42 ...	·11
1936 ...	12 ...	9·87 ...	32 ...	·13

The experiment was repeated, with similar results. This seemed to indicate that the age of the seed might be an important factor in determining the position of the first truss. This is now being investigated.

The next problem was to what extent environmental factors affected the position of the flower truss, apart from altering the assimilating area of the plant. The mean position

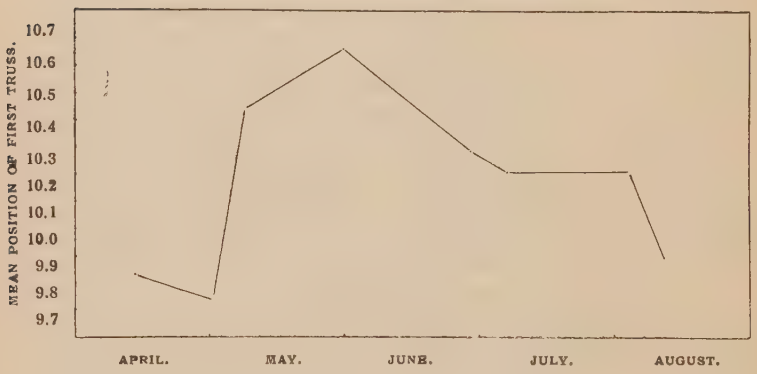
of the first truss was recorded in a number of batches sown at different times during the summer of 1936, and the results are shewn in Table 5 and Fig. 1.

Table 5.

Date of Sowing.	Mean position of first truss.	Probable Error of mean.
April 14th	9·83 ...	·11
May 2nd	9·74 ...	·13
May 8th	10·44 ...	·08
June 1st	10·66 ...	·06
June 29th	10·28 ...	·11
July 6th	10·20 ...	·06
August 4th	10·21 ...	·11
August 11th ...	9·88 ...	·07

Figure 1.

Seasonal change in position of first truss.



These results suggested that at midsummer the truss was formed at a later stage in the plant's development than at other times. Accordingly, an experiment was performed to determine whether length of day was a factor affecting the truss position, since this has been found in cereals to determine the number of leaves formed before the ear. One box of seedlings was grown under a wooden frame covered with a black cloth, which was raised only between the hours of 7 a.m. and 2 p.m., while another seed box was grown by the side of it, but in the full July day of about seventeen hours. The experiment was repeated in August, and the results are given in Table 6.

Table 6.

Date of Sowing:—	June 12th.	August 17th.
Mean truss position, full day ...	11·89	10·88
Mean truss position, short day ...	11·14	10·27
Number of plants	69	53
"t"	5·27	2·09
"p"	<·01	<·05

Thus, the plants grown under short-day treatment formed their first truss at an earlier stage of development than those under normal illumination, although the assimilating area of the former was very much smaller.

The positions of subsequent trusses are largely dependent on that of the first truss. Those on the main stem usually follow one another at intervals of three nodes, while the position of the first truss on each lateral shoot also varies with that of the first truss on the main stem (Table 7).

Table 7.

Position of first truss on main stem.	No. of plants.	Mean position of first truss on laterals 1—18.	
		"t."	"p."
9 ...	9 ... 8·03		
10 ...	6 ... 8·20	2·18 ...	·05
11 ...	2 ... 8·68	1·67 ...	·10
12 ...	1 ... 9·00	1·40 ...	·15

On the other hand, the position of the truss on the lateral shoot was also dependent upon the height of the node from which the shoot arose (Table 8 and Fig. 2).

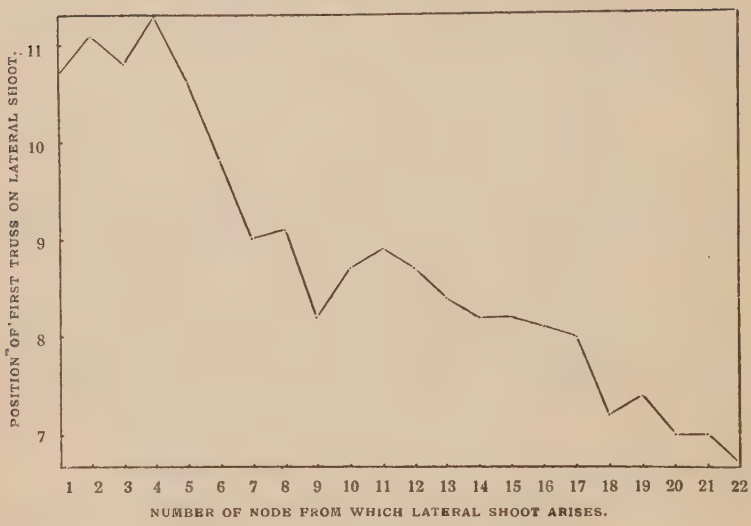
Table 8.

Laterals at nodes Nos.	Mean position of first truss.	Probable error of mean.
1— 4 ...	9·97 ...	·11
5— 8 ...	8·68 ...	·09
9—12 ...	7·78 ...	·07
13—16 ...	7·22 ...	·09
17—20 ...	6·44 ...	·12
21—22 ...	5·91 ...	·06

A series of this sort is more or less what one would expect from the relation between the assimilating area and the position of the first truss, for the number of leaves present when the first lateral shoot develops is obviously less than when the twentieth does so. But the problem here is complicated by the presence of trusses already formed, as well as by many factors not yet investigated, and a great deal of further work is needed to clarify the position.

Figure 2.

Position of the first truss on lateral shoots.


POSITION OF FIRST TRUSS ON LATERAL SHOOT.
11
10
9
8
7
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
NUMBER OF NODE FROM WHICH LATERAL SHOOT ARISES.

Summary.

It is found that in summer the position of the flower truss on the main stem is related to the previous growth of the plant. Length of day affects it, and it is suggested that age of seed may also be a factor concerned.

The lateral shoots from the higher nodes form trusses at an earlier stage than do those from the lower nodes.

3. Seasonal and Diurnal Changes in the Water Content of the Tomato Seedling.

D. W. Goodall.

The importance of water in plant growth is well known, and it is recognised that differences in crop production and susceptibility to disease may be due to differences in water content. The amount of water in a plant may be regarded as the difference between that lost by evaporation from the stem and leaves and the amount taken in by the roots, which in turn depends upon the extent and health of the root system and the physical conditions in the soil.

When a plant is exposed to favourable conditions of light and temperature the rate of water loss is high, and at the same time rapid assimilation is taking place. If the proportion between water and dry material in the plant is to remain

constant, sufficient water must be taken up to balance the new assimilate formed, as well as to replace the loss by evaporation. Previous work has shewn that, during a summer day the tomato plant does not take up water sufficiently fast to maintain equilibrium, and that the resulting deficiency is made up during the following night. In winter, however, any water deficiency produced during the day is negligible. These earlier experiments, however, gave no information concerning the changes in water content of individual leaves, so the work described below was undertaken.

The plants to be employed were first carefully selected for uniformity. No plants in which the first two leaves were opposite were included, for these had been demonstrated to differ physiologically from the other plants. The growth rates of the leaves were determined, and those plants with aberrant values were rejected. The plants finally selected were only from 30% to 50% of the number potted. These were then divided into groups of from eight to ten plants, and the groups were taken at intervals through a period of twenty-four hours. Each leaf was weighed both immediately after removal from the plant, and after being dried for twenty-four hours at 70°C.

The results were calculated as the percentage of dry matter in the leaf.

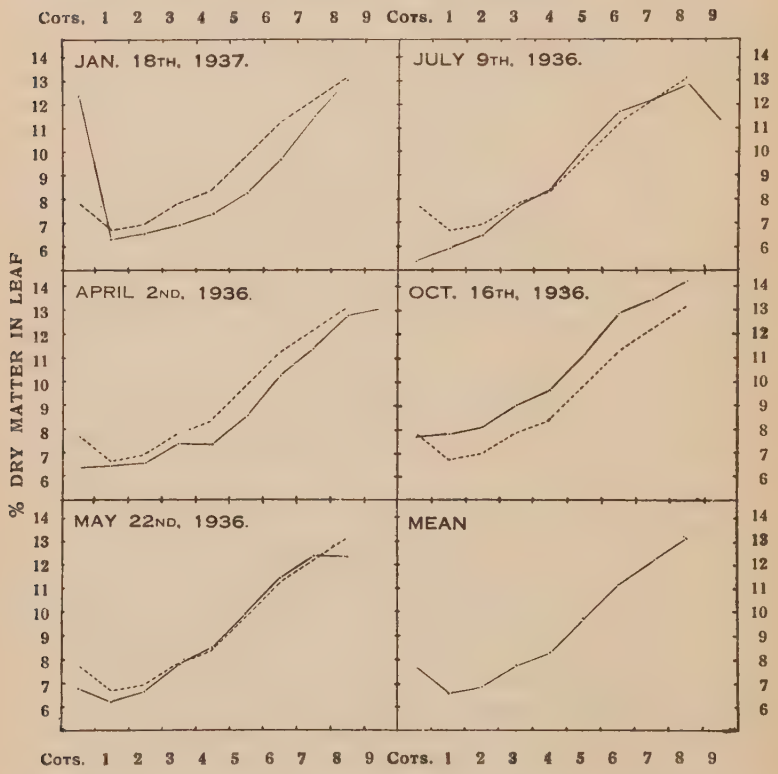
Fig. 1 shews the water content of leaves at mid-day at five different times of the year. It will be seen that, throughout the year, the younger leaves have a lower water content than the older ones. There are three exceptions. In two cases, the cotyledons have a lower water content than the first foliage leaf. This indicates that they are already approaching senescence and its sequel, abscission. In one case, the July sample, the smallest leaf has a higher water content than the rather older ones. This is probably because the rate of supply by translocation of sugars to this leaf has not at mid-day yet become rapid enough to replace the loss by respiration. In each graph, except that for January, the curve has an inflection at about the sixth leaf; this probably indicates that the younger leaves still largely consist of actively dividing cells, and that vacuolation does not yet play a major part in their growth.

If the curve for each experiment is compared with the mean for the year, it will be seen that the water content in winter is throughout higher than the mean, and does not become equal to the mean value until midsummer. In October, on the other hand, the water content in all the leaves is much below the mean; this is probably explained by the

Figure 1.

Seasonal Changes in % Dry Matter in Leaves of Tomato Seedling, Variety B.S. 1, at Mid-day.

The broken line in each graph is the mean curve for the year.



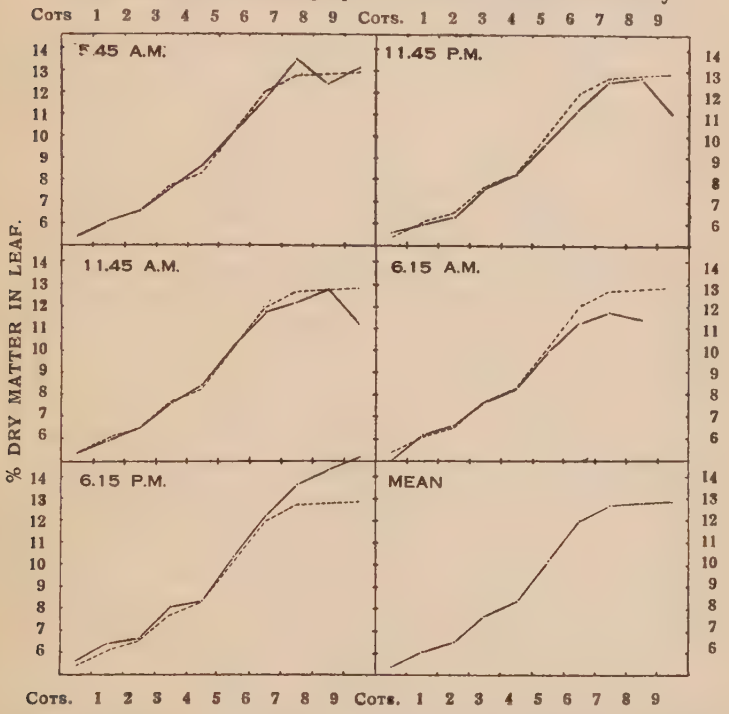
fact that the development of these plants took place during the weeks immediately preceding the resumption of heating in the glasshouse, since the low temperatures would reduce the amount of water absorbed by the roots.

The changes in water content of the leaves during the course of a day are smaller than the seasonal variation, but are none the less interesting. In Fig. 2 are shewn the values for five samples taken during a day in July. In the early morning graph there is little deviation from the main curve; at mid-day the same is true except for the young leaves, which have all a higher water content than the mean. This suggests that the translocation to these leaves of material for growth is still taking place only slowly in relation to the rate

Figure 2.

Diurnal Changes in % Dry Matter in Leaves of Tomato Seedling, Variety E.S. 1, on 9th July, 1936.

The broken line in each graph is the mean curve for the day.



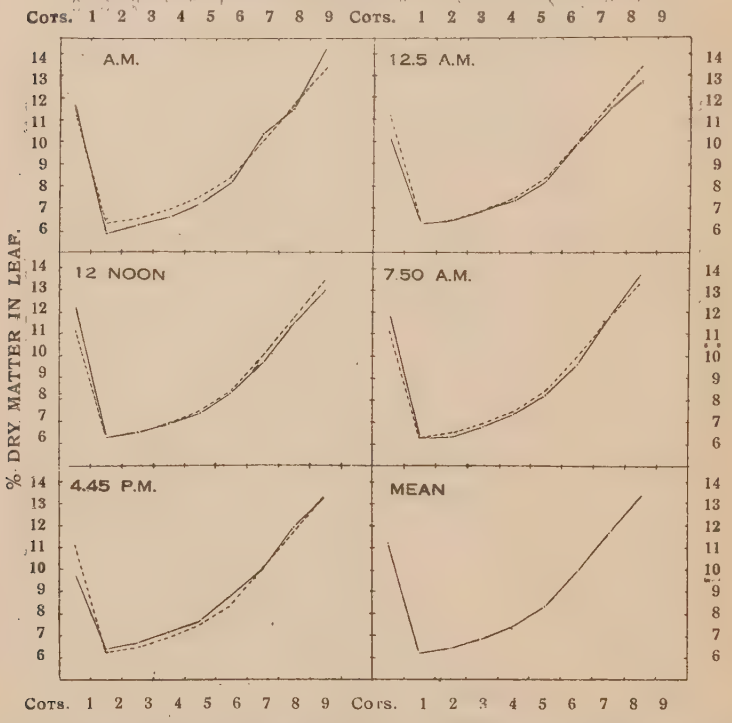
of water uptake. In the evening this condition is reversed and all leaves, including the younger ones, have a water content below the mean. This suggests that by this time the small leaves have received enough material to supply most of their needs for respiration and active growth during the night. By midnight, however, the water content of the smaller leaves has already risen slightly above the mean, shewing that the utilization of most of the material has already taken place. In the second morning sample their water content remains higher than during the previous day, for these leaves are now older and the plant is at a more advanced stage of development.

In January, on the other hand (Fig. 3), the diurnal changes are very small. In the morning the leaves have a slightly lower, and in the evening a slightly higher, water content than the mean; this may be explained by the accumulation of assimilate during the day. Both transpiration on

Figure 3.

Diurnal Changes in % Dry Matter in Leaves of Tomato Seedling, Variety E.S. 1, on 18th January, 1937.

The broken line in each graph is the mean curve for the day.



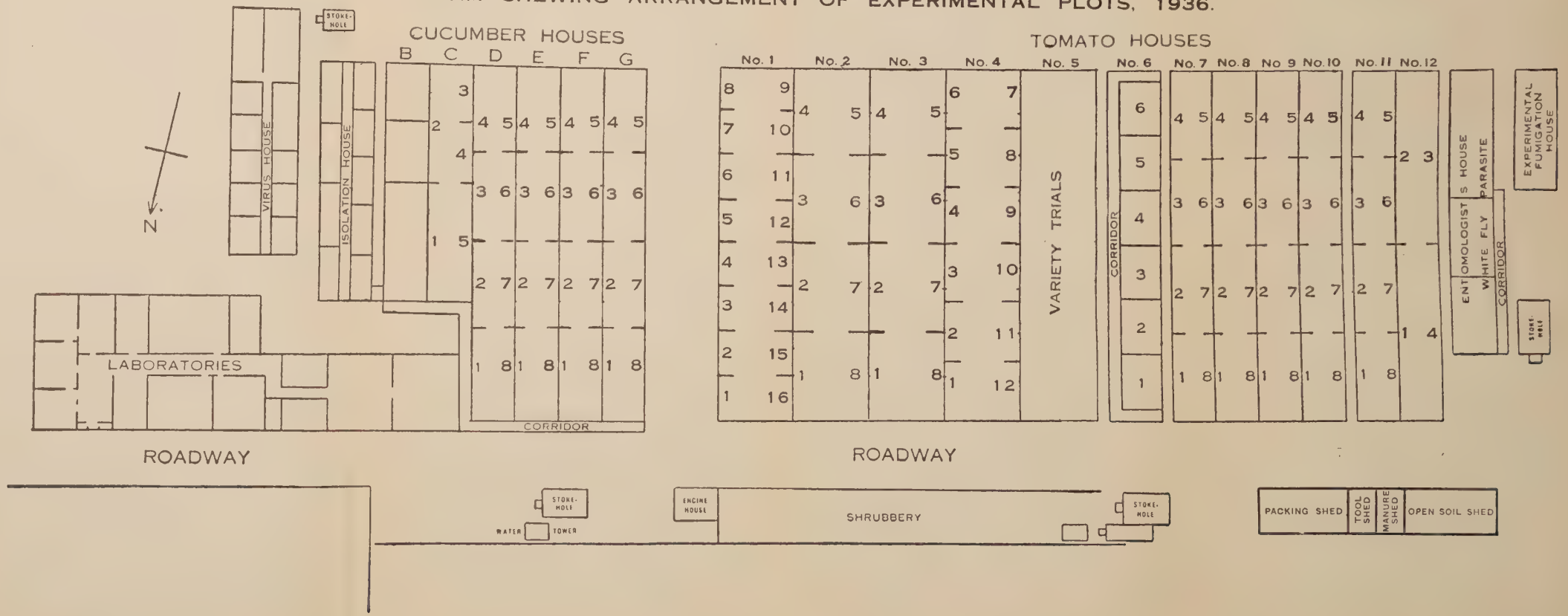
the one hand, and translocation to the younger leaves on the other, remain much more constant through the day than in summer, and consequently the small leaves do not deviate appreciably from the mean curve.

The general conclusions to be drawn from these experiments are:—

(1) The variation of water content through the year affects all leaves of the plant similarly. A maximum is normally reached in early spring, and a minimum in the autumn.

(2) Diurnal changes in water content of the leaves are small, with the exception of the young leaves in summer. These reach a minimum in the evening, and attain a maximum in the early morning. This suggests that the latter is the most dangerous time for infection with mildew, which takes place most readily when the leaf is fully turgid.

DIAGRAM SHEWING ARRANGEMENT OF EXPERIMENTAL PLOTS, 1936.



APPENDIX A.

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APPENDIX B.

Manural Treatment in Tomato Experiments.

(1) Lime.

All houses received ground caustic lime at the rate of 2 tons per acre.

(2) Stable Manure.

Houses 1, 2, 6, 8 to 10, received 15 tons horse manure per acre, except plots 1, 2, 3, 13 and 14, house 4.

(3) Base-dressing.

Houses 1 to 4, 6, 8 to 10 received $\frac{3}{4}$-lb. per square yard of the following mixture :—

1 part bone meal.
1 part bone flour.
1 part hoof and horn.
1 part sulphate of potash.

Houses 5, 7, 11 and 12 received $\frac{1}{4}$-lb. sulphate of potash per square yard only.

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APPENDIX B.—**(4) Top-Dressing.**

FERTILISER MIXTURE—3 parts sulphate of potash should read 3 parts sulphate of ammonia.

t top-dressing of
are yard.

1, 2, 3 and 12,
are yard of the
tion :—

3 parts sulphate of potash.
2 parts dried blood.
7 parts 30% superphosphate.
5 parts pure dissolved bones.
½ part bone flour.
2½ parts sulphate of potash.

All houses received three top-dressings of the following mixture at the rate of 2-ozs. per square yard :—

1 part sulphate of ammonia.
1 part nitrate of potash.
3 parts superphosphate.
5 parts dried blood.

Appendix C.

Manures applied to Plots 1-3, and 12-14 in Tomato House 4.

Plot.	TITLE.	Base Manure in Lbs. per sq. yd.				* Top-dressing in Lbs. per sq. yd.			
		Lime.	Stable Manure.	Basic Slag.	Sulphate of Potash.	Super-phosphate.	Sulph. of Ammonia.	Nitrate of Soda.	Sulph. of Potash.
1	Complete Artificials (I.) without Nitrogen	1.0	—	0.4	0.1	0.5	—	—	0.2
2	Unmanured	1.0	—	—	—	—	—	—	—
3	Complete Artificials	1.0	—	0.4	0.1	0.5	0.2	0.2	0.2
12	Complete Artificials with Dung	1.0	7	0.4	0.1	0.5	0.2	0.2	0.2
13	Complete Artificials without Phosphates	1.0	—	—	0.1	—	0.2	0.2	0.2
14	Complete Artificials without Potash	1.0	—	0.4	—	0.5	0.2	0.2	—

* The Top-dressing was applied in eight equal instalments.

Appendix D.

Dates of Cultural Operations 1935—1936.

Crop.	Sown.	Potted into 60's.	Potted into 32's.	Planted out in borders.	First Mulching.	First Top Dressing.	First Fruit Picked.	Last Fruit Picked.
Cucumbers	Dec. 17 1935	——	Jan. 15 1936	Feb. 7 1936	Mar. 18 1936	Mar. 23 1936	Mar. 16 1936	Aug. 14 1936
Tomatoes	Dec. 19 1935	Jan. 18 1936	——	Mar. 10 1936	——	May 5 1936	May 29 1936	Oct. 23 1936

Month.	Air Temperatures						Grass Temp.			Rainfall				Mean Soil Temperatures		Hygrometer				Bright Sunshine		Barometer
	Mean		Absolute Max.		Absolute Min.		Av. Min.	Absolute Min.		Total Precipitation	No. of Days P'ptn.	Greatest Fall				Dry Bulb	Depres. of Wet Bulb	Relative Humidity %	Dew Point	Total No. of Hrs.	Daily Average.	
	Max.	Min.	Tem.	Date	Tem.	Date		Tem.	Date			Amt.	Date	1 ft.	2 ft.							
	°F.	°F.	°F.		°F.		°F.	°F.		Ins.		Ins.		°F.	°F.	°F.	°F		°F.			Ins.
January	45.2	33.1	57.0	9th	20.0	18th	25.7	17.0	18th	3.89	20	0.81	29th	40.0	41.3	41.0	1.5	85.8	37.9	32.1	1.0	29.52
February	43.8	31.7	53.0	18th	20.0	11th	27.0	14.0	11th	1.79	12	0.60	17th	37.1	38.1	38.9	1.5	88.0	35 2	76.7	2.6	29.64
March	52.7	39.9	63.0	21st 22nd	30.0	3rd 6th	34.9	25.0	3rd 6th	1.28	11	0.35	26th	42.7	43.0	47.7	3.1	79.6	41.3	71.4	2.3	29.75
April	53.3	36:6	64.0	28th	27.0	20th	31.6	22.0	20th	1.30	9	0.55	27th	45.5	45.9	46.6	3.8	75.9	34.9	92.7	3.1	29.83
May	68.7	44.5	81.0	17th	32.5	28th	39.7	29.0	28th	0.89	4	0.71	6th	54 3	53.9	56.8	4.3	74.3	48.5	124.2	4.0	29.98
June	71.0	51.8	86.0	19th 20th	38.0	2nd 3rd	48.9	35.5	1st	4.70	17	0.69	21st	59.7	57.2	61.5	5.2	69.8	52.1	149.2	4.8	28.73
July	69.1	53.1	76.0	5th	44.0	9th	49.9	41.5	29th	2.24	15	0.52	9th	63·7	63.4	64.4	4.7	75.9	55.1	122.2	3.9	29.35
August	72.3	51.7	83.0	30th	43.0	22nd	48.3	41.0	22nd 28th	0.31	4	0.18	10th	61.5	61.6	66.6	4.7	75.6	58.1	153.0	4.9	30.11
September	66.2	50.7	75.0	2nd 11th	39.0	28th	47.1	35.0	29th	2.35	14	0.46	4th	59.8	60.2	59.9	3.1	77.0	48.5	75.9	2.5	30.03
October	56.6	39.7	66.0	14th 15th	29.0	28th	35.1	24.0	8th	2.25	11	0.80	30th	48.9	51.4	52.7	4.0	75.0	44.8	75.1	2 5	30.09
November	50.8	36.1	55.0	9th 16th 17th	25.0	10th	33.8	25.0	28th	2.11	10	0.85	11th	44.0	46.4	45.7	1.9	87.3	41.8	17.1	0.6	29.85
December	47.6	36.5	55.0	2nd 17th	23.0	7th	32.6	20.0	7th	0.96	10	0.26	14th	40.9	42.7	45.1	1.3	94 5	40.7	42.1	1.3	33.47

Total rain for year, 24.07 ins. No. of days precipitation, 137. Total bright sunshine for year, 1031.7 hours.